AN INVESTIGATION OF THE SURROGATESHIP OF THE GNP DEFLATOR FOR WHOLESALE PRICE INDICES

By

KATHERINE JANE HOHL

Bachelor of Arts
University of Oklahoma
Norman, Oklahoma
1969

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1972

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Thesis Approved:

Larry G Chunter
Thesis Adviser

Ansel M. Sharp

James R Barton

William H. Rambo

Norman N Durham
Dean of the Graduate College

PREFACE

This study is concerned with the evaluation of arguments as to whether specific price indices in groups of price indices are surrogated by a general price index for accounting purposes. It is a simulation designed to provide preliminary evidence toward answering the question of whether general price level adjustments approximate current replacement costs in financial statements.

I would like to express my appreciation to the members of my dissertation committee for their assistance in this study; particular thanks are due to Drs. James R. Boatsman and Lanny G. Chasteen for their efforts. I also thank my former committee chairman, Dr. Germain Böer, for his encouragement before and during the project.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Implicit in debates between advocates of the use of current replacement costs (specific price indices) and advocates of the use of general price level adjustments in financial reporting is the assumption that applications of these two methods of dealing with the nonconstant purchasing power of the dollar yield significantly different results. This study is an attempt to provide empirical evidence as to the validity of that assumption.

Two Suggested Approaches to the Problem

The Accounting Principles Board has concluded that general price-level financial statements present useful information not available from historical cost financial statements; accordingly, they have recommended the presentation of general price-level financial statements as supplementary information to basic historic cost financial statements.[1] After issuance of a memorandum discussing possible options, the Financial Accounting Standards Board dropped the proposal to require some sort of general price level information;

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[1]APB Statement No. 3, "Financial Statements Restated for General Price-Level Changes" (New York, 1969), p. 9013.

presentation of this type of information continues, therefore, to be voluntary.[2] In a departure from a general price-level approach, the Securities and Exchange Commission has adopted a rule requiring of certain companies that replacement cost information be disclosed in annual financial statements.[3]

The accounting literature includes many suggestions for dealing with the problem of changing price levels, the positions of the Accounting Principles Board and the Securities and Exchange Commission exemplifying the two approaches suggested perhaps more often than any others--general price-level adjustments, and current replacement cost adjustments.

In general, accounting theorists have approached the problem of changing price levels by postulating various decision-making processes, and then constructing theories logically derived from the postulated models.[4] That a

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[2] The Wall Street Journal, June 4, 1976, p. 9.

[3] Securities and Exchange Commission, Accounting Series Release No. 190, March 24, 1976.

[4] Edwards and Bell, for example, assume that "evaluation of past decisions" is an intrinsic part of decision making, and construct a system to establish comparability of ex ante and ex post data for evaluative purposes. Edgar O. Edwards and Philip W. Bell, The Theory and Measurement of Business Income (Berkeley and Los Angeles, 1970), pp. 3-4. Revsine and Weygandt assume prediction of future cash flows is a crucial decision variable, and argue for a specific price change approach on the basis that the resulting figures indicate maintenance of physical operating levels, and thus facilitate predictions of cash flows. Lawrence Revsine and Jerry J. Weygandt, "Accounting for Inflation: the Controversy," The Journal of Accountancy (October, 1974), p. 76.

diversity of logically-supported theories for dealing with the fluctuating purchasing power of the dollar may be found in the accounting literature is not surprising, given the diversity of possible assumptions as to decision-making processes underlying the theories.

It would seem that until (unless) agreement in the underlying behavioral assumptions and concepts can be reached, various authors' policy-making conclusions as to how to deal with changing price levels will coincide only by coincidence. However, it has been suggested that, despite theoretical differences, results of applying diverse policy conclusions in the specific versus general index controversy are essentially the same. Boersema has suggested that general price-level adjusted costs may be surrogates for current values;[5] if this is so, the theoretical disagreements between those who favor replacement costs and those who favor general price level adjustments cease to be moot. Practically if not conceptually, general price level adjustments would accomplish results advocated by replacement-cost proponents.

Revsine and Weygandt, on the other hand, cite examples of specific indices which differ significantly from the Gross National Product Implicit Price Deflator, in arguing that a general index often does not surrogate specific

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[5]John M. Boersema, "The Case for General Price-level Accounting," CA Magazine (April, 1974), p. 29.

individual indices.[6]

Revsine and Weygandt, however, do not simply argue that a general index does not surrogate specific indices. Rather, they refine their argument to incorporate the idea that use of indices (general or specific) "to reflect price changes ... implicitly incorporates specific assumptions regarding the firm's reinvestment activity as assets physically deteriorate."[7] According to their argument, use of a general index implies that funds "are potentially available for reinvestment in any type of asset the firm deems appropriate," and that use of specific indices implies "the firm will replace existing assets with essentially similar assets."[8]

With these assumptions, the issue then becomes which reinvestment assumption is more appropriate. Their conclusion is that homogeneous reinvestment is the appropriate assumption for the majority of firms:

> It is conceivable that for a highly diversified conglomerate enterprise, the reinvestment assumption implicit in the GNP Deflator approach may be approximately correct.... But for this reinvestment assumption to be even approximately correct, the conglomerate enterprise must be quite large and its existing and contemplated lines of activity must be diverse.
>
> For all other types of firms, the reinvestment assumption implicit in the specific index approach would appear to be superior. That is,

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[6] Revsine and Weygandt, p. 77.

[7] Ibid.

[8] Ibid.

> if the firm is in a single line of activity the reasonable assumption is that the firm will not soon become sufficiently diversified to validate the reinvestment assumption implicit in the general index approach. Such firms may (and probably will) diversify in the future, but only into a few areas, and only over a lengthy period. Since the diversification transition--if it takes place at all--will be slow, and since we cannot know in advance which new area (or areas) the firm will choose, the best reinvestment assumption is likely reflected by reference to the assets currently in use.[9]

Their argument for the use of current replacement costs thus rests upon two empirically testable hypotheses--that a general index does not surrogate most specific price indices, and that price movements of heterogeneous and homogeneous groups of assets are differentially surrogated by price movements of the GNP Deflator (their assumption being that price movements of heterogeneous groups only are surrogated by the GNP Deflator).

Objectives of the Study

One objective of the study is to evaluate empirically the argument that the general price index surrogates specific price indices.

A second objective is to evaluate the contention that homogeneous and heterogeneous groups of indices are significantly different in the degree to which they are surrogated by the GNP Deflator.

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[9] Ibid., pp. 77-78.

Methodology

In the research, price indices (from the U.S. Bureau of Labor Statistics wholesale price series) for 62 individual assets were compared in terms of price behavior to the GNP Deflator. The degree of association between each specific index and the GNP Deflator was determined by computing for each comparison a number arbitrarily called an S value. All S values are positive or zero; the nearness of each computed S value to zero represents relative convergence of underlying percentage price changes in the indices being compared, and therefore the substitutability, for accounting purposes, of the two indices. An S value of zero indicates identical percentage price changes in indices; increasing S values indicate increasing divergence in percentage price changes of indices being compared.

A cut-off point, below which surrogation of indices by the GNP Deflator was assumed to take place, was determined with reference to the price behavior of the entire sample of indices. The resulting evidence as to the surrogateship of individual indices by the GNP Deflator was used to address empirically the argument that the general price index surrogates specific price indices.

Each index was then averaged with the specific index most like it (homogeneous groups) and with the specific index most unlike it in relation to the GNP Deflator (heterogeneous groups), and the homogeneous and heterogeneous groups compared to the GNP Deflator. The next step was to

add a third like and unlike index to the groupings, with the iterative process continuing until most groups were surrogated by the GNP Deflator. The relative convergence of price movements of the homogeneous and heterogeneous groups of indices to price movements of the GNP Deflator provided evidence as to the differential surrogation of homogeneous and heterogeneous groups by the general index.

Significance of the Study

Sales and receipts by multi-industry companies accounted for approximately 45 percent of all industrial sales and receipts in 1967.[10] As homogeneous diversification into similar products need not cross industry barriers, this is a conservative estimate of the proportion of industry potentially falling into the category of having the price behavior of its assets, as a group, surrogated by the GNP Deflator. Although this study is a simulation, not an examination of actual asset holding by firms, it addresses an issue potentially affecting a significant proportion of industry.

Limitations of the Study

This study is limited to an attempt to evaluate empirically an argument involving price indices. Although

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[10]From Enterprise Statistics 1967, Part I, Table 2-1.

real-world counterparts to certain data were mentioned, the study is envisioned as a preliminary investigation simulating more extreme dichotomies of expansion or reinvestment activity than probably occur in the majority of actual firms.

A serious limitation in any attempt to generalize results is the use of equal weights for the various indices in the merger process; this would directly correspond only to situations where companies had equal investments in various areas of activity. Further research would be required to determine the extent to which companies' actual asset holdings correspond to these assumptions, and to evaluate how deviations from the assumptions of extremity of merget activity and equal proportions of asset holdings would affect results obtained in the present study.

The relative overall price stability during the time period in which index observations were made is another limitation in generalizing results. It does not necessarily follow that relationships among price indices which existed in the period 1957-1966 also exist in other (current) times.

The operational definition of surrogation based on S values was made arbitrarily, and as such is open to challenge. A nonarbitrary definition of surrogateship would require that the behavioral problem of how price-level data are used in the decision making process, as well as the problem of defining materiality in an accounting context--how much difference in percentage price changes between

indices must occur so that results obtained by using one index would cause different decisions than results obtained by using another index--be specifically investigated, which is beyond the scope of the present study.

Price indices were not chosen randomly from the general population of all possible indices, and therefore were not strictly representative.

Two of the limitations, the use of equal weights for the indices in groups, and the operational definition of surrogateship, are examined in more detail in later chapters.

Organization of the Study

Chapter II includes a review of arguments found in the accounting literature for the use of current replacement costs and general price level adjustments. Also presented are suggestions that the two approaches might in application yield substantially identical results, and a brief discussion of merger activity of firms.

Chapter III includes a discussion of the development of the measure of surrogateship used in the study, and an extended example illustrating application of the measure. In Chapter IV, operational definitions of surrogateship, and of homogeneous and heterogeneous groups of indices are presented. The example from Chapter III is continued to illustrate the computational procedures used to determine the groups.

The original arguments are evaluated in Chapter V, and implications of the results are discussed. Chapter VI summarizes the study and presents conclusions and recommendations for further research.

CHAPTER II

LITERATURE REVIEW

The following review of literature consists largely of a summary of theoretical arguments which have been made for the use of general price-level adjustments and for the use of current replacement-cost adjustments in financial statements. These are by no means the only valuation methods proposed for dealing with the nonconstant purchasing power of the dollar; they are, however, the methods associated with the categories of price indices used in the present simulation.

Definitions

General price-level financial statements are statements in which historical costs are restated "in terms of dollars of common purchasing power as of a specified date."[1]

Current replacement-cost financial statements are statements which reflect "costs which would be incurred if the assets were acquired on the balance sheet date."[2]

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[1]Financial Accounting Standards Board, Reporting the Effects of General Price-Level Changes in Financial Statements, FASB Discussion Memorandum (Stamford, Conn., Feburary 15, 1974), p. 1.

[2]Walter B. McFarland, Concepts for Management Accounting (New York, 1966), p. 116.

Replacement and Reproduction Cost

There is some dispute over what precisely is meant by "the assets" whose current replacement costs are being measured. Sweeny defines reproduction cost as " ... the cost to obtain or build a precisely similar asset," and replacement cost as " ... the cost to obtain or build an asset that will perform the same service ...."[3] Rosen terms these alternatives "replacement cost," meaning costs of duplicate assets, and "replacement value," meaning costs of the most up-to-date assets which perform the same services.[4] According to Paton and Paton,

> It should be understood that the significant replacement cost is the cost of providing the existing capacity to produce in terms of the most up-to-date methods available. Thus it's largely a waste of time to estimate the cost of replacing an obsolete or semiobsolete plant-unit literally in kind; such an estimate will neither afford a basis for sound appraisl of the property nor furnish a useful measure of current operating costs ....[5]

Edwards and Bell, on the other hand, argue that " ... if the quality changes are significant ..., it will be misleading to use the price of the new, improved substitute product as a basis for determining the current cost of using the old

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[3]Henry W. Sweeney, Stabilized Accounting (New York, 1936), p. 44.

[4]L. S. Rosen, "Replacement-Value Accounting," The Accounting Review, XLII (1967), pp. 106-107.

[5]William A. Paton and William A. Paton, Jr., Asset Accounting (New York, 1952), p. 325.

one."[6] In a footnote, they elaborate on this statement:

> It must be remembered that is is not the current cost of equivalent services provided by the fixed asset over some time period which we wish to measure, but the current cost of using the particular fixed asset which the entrepreneur chose to adopt and is still using. It is that particular decision that the entrepreneur wishes to evaluate on the basis of accounting data.[7]

Chambers, too, sees reproduction costs of up-to-date assets as being

> ... no different in principle from the price of any asset different in kind or function from the asset already held. It is simply the price of a good which the firm does not now hold. Although it is a contemporary price, it is not the price appropriate to a description of the asset which the firm does not hold, or appropirate in a statement purporting to represent the present financial position or capacity ... of the firm.[8]

Theoretically, these are two diverse viewpoints based upon diverse premises. Paton and Paton argue that the use of current costs of up-to-date machinery provides users with a measure of current operating costs; Edwards and Bell, however, as Chambers, see these not as the firm's actual current operating costs, but as opportunity costs--costs of an option that has not been chosen. In their opinion, current costs of operations include the current costs only of the particular assets actually in use.

Whether applications of the two viewpoints would yield

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[6] Edwards and Bell, p. 186.

[7] Ibid.

[8] R. J. Chambers, "Replacement Price Accounting," The Accountant, CLXII (1970), p. 486.

significantly different results in the majority of real-world situations is an empirical question. It can be argued that if production methods become in a realistic sense obsolete, management has the choice of replacing them in order to stay competitive, or going out of that type of business. Although focusing on a different implication, Kohler argues that obsolete assets are in fact replaced when he notes that "Because of rapid changes in production devices and methods since World War II, a large part of the fixed assets of the average manufacturing business has been recently acquired."[9] It would seem that only during the transition stage between obsolescence and either replacement or closure (the duration of which is also an empirical question) would significant differences between the current cost of the asset in use and the current cost of the most technologically-advanced assets arise. The assumption made in the definition of current replacement costs is that minor quality changes will in some manner be reflected in specific price indices, and that major technological advances will generate replacement or termination so that for practical purposes replacement and reproduction costs are synonymous.

Measurement of Replacement Cost

The assumption was just made that minor quality changes will be reflected in specific price indices; this leads to

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[9]Eric L. Kohler, "Why Not Retain Historical Cost?" The Journal of Accountancy (October, 1963), p. 39.

the point that most authors accept the option of measuring replacement cost by "the use of price index numbers for like fixed assets to adjust the original cost base to the level which would now have to be paid to purchase the asset in question."[10] "The use of specific price indexes involves the adoption of the replacement cost ... principle of valuation ...."[11]

That there is a conceptual distinction, however, between values resulting from adjustments using specific price indices and actual current replacement costs is pointed out by Hendriksen:

> ... the result [of multiplying original costs by specific price indices] is not necessarily a good approximation of current replacement values but it may be an approximation of specific purchasing power. The historical costs are determined by the market conditions for the specific items at the time of acquisition rather than by current market conditions. Also efficiencies or inefficiencies of purchase or production will be reflected in the historical costs adjusted by specific price indexes.[12]

Hendriksen views amounts obtained by multiplying original costs by specific price indices as an approximation of the current purchasing power in the areas (in terms of

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[10] Edwards and Bell, p. 186.

[11] Staff of the Accounting Research Division, Reporting the Financial Effects of Price-Level Changes, Accounting Research Study No. 6 (New York, 1963), p. 29.

[12] Eldon S. Hendriksen, "Purchasing Power and Replacement Cost Concepts--Are They Related?" The Accounting Review, XXXVIII (1963), p. 489.

asset types) of original investment, rather than as the actual current costs of the assets' services.[13]

The conceptual distinction between the two is not questioned; rather (again, the significance of which is an empirical question) the practical difference. The position taken in this study is that of most authors; not that current replacement costs and original costs multiplied by specific price indices are conceptually identical, but that current replacement costs may be measured through the use of specific indices.[14]

Uses of Accounting Data

It is generally assumed that accounting data are to be used in some sort of evaluative or decision-making process, although, as Scapens points out, "Whilst the assumption of a decision-making objective may be accepted as realistic it must be stressed that is is only an assumption."[15] From this starting point, however, theorists' views diverge as to the nature (purpose) of and users of accounting data. Gynther speculates that " ... it depends on one's environment and on one's subconscious ideas on for whom or for what

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[13] Ibid., p. 490.

[14] Edwards and Bell, p. 186. See also R. S. Gynther, Accounting for Price-Level Changes--Theory and Procedures (New York, 1966), p. 42.

[15] R. W. Scapens, "Accounting for Inflation," The Accountant, CLXIX (1973), p. 643.

accounting systems are maintained;"[16] be this as it may, the philosophical differences are used by theorists to justify normative proposals for the use of historical cost accounting or current replacement cost accounting.

Nature of Accounting--Valuation or Allocation Procedure?

One basic philosophical difference between advocates of general price-level adjustments (essentially historical cost accounting restated in common dollars) and advocates of current replacement-cost accounting is whether accounting is (or should be) concerned with tracing costs and revenues actually incurred, or with describing the firm's current financial situation without necessarily referring to amounts involved in the historical transactions giving rise to the current financial situation. This difference may also be described in terms of a time perspective--whether accounting is concerned with the past (historical costs) or with the present (current replacement costs).

A variation of an overt time-dimension concern is for a theorist to define costs and revenues with reference to particular time horizons, then to justify the normative preference by its conformity with the definition. Thus,

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[16]Gynther, p. 44.

cost is defined as

> ... the amount, measured in money, of cash expended or other property transferred, capital stock issued, services performed, or a liability incurred, in consideration of goods or services received or to be received.[17]

Historical costs (the past tense is used in the definition--measured, expended, transferred, etc.) which originate in actual entity transactions (which are specifically listed in the definition) are the normative preference when costs are defined as above.

A different definition of cost is given by Baxter and Carrier (who indirectly note the dependence of the definition process upon uses to be made of definitions in the first sentence).

> When anything more than a record of stewardship is wanted, cost measurement should be forward-looking. Just as value is a matter of expected future benefits, so too cost is a matter of future sacrifices. The cost to a firm of a given job is the job's effect in worsening the future cash flow. Thus, when the firm turns an existing asset into input for the job, typically the adverse consequence is that the firm will pay cash to replace the asset; so the cost of using up this asset is its replacement price.[18]

Baxter and Carrier, then, define costs as the cash the firm will pay to replace the asset, which they further equate with current replacement price (an objection to this equation is discussed later). But by conforming to their time-

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[17]Paul Grady, Inventory of Generally Accepted Accounting Principles for Business Enterprises, Accounting Research Study No. 7 (New York, 1965), p. 433.

[18]W. T. Baxter and N. H. Carrier, "Depreciation, Replacement Price, and Cost of Capital," The Journal of Accounting Research, IX (1971), p. 191.

horizon-inclusive definition of costs, replacement costs become the logical normative preference.

To return to the debate as to whether accounting is a valuation or an allocation procedure: a not uncommon answer to this seemingly either-or question is that accounting is both. Statements to the effect that a departure from cost should be made only when cost fails to represent current value imply that costs are perceived as representing (measuring) current values, although the two may be conceptually distinct. Some different viewpoints are expressed in the following quotations.

> Accounting is ... not essentially a process of valuation, but the allocation of historical costs and revenues to current and succeeding fiscal periods ....[19]

> It [the allocation of historical costs and revenues] was ... and is ... the basic standard of asset valuation which has been built into the corporate financial statements ....[20]

> It can be argued that value information if it is accurate is the theoretical goal and the most useful of information.[21]

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[19] American Accounting Association, "Statement of Accounting Principles Governing Corporate Reports," 1936, quoted in Eric Kohler, "Why Not Retain Historical Cost?" The Journal of Accountancy (October, 1963), p. 37.

[20] Kohler, p. 39.

[21] Harold Bierman, Jr., "Discounted Cash Flows, Price Level Adjustments and Expectations," The Accounting Review, XLVI (1971), p. 694.

> Where does an accountant depart from recorded cost? When cost no longer represents existing value, then the departure point is imminent.[22]

> Departure from the standard policy of adhering to cost at date of acquisition ... should be considered only where such a substantial and persisting change has occurred as to render accounting on the old basis inadequate and invalid ....[23]

> If the inflationary movement continues, some basis of valuation other than historical cost must be employed in the accounts if the resultant statements are to be anything more than historical curiosities.[24]

Accounting also would seem to lie in the eyes of the beholder. Whether the lack of concensus as to the nature of accounting gave rise to the historical cost versus current valuation schools of thought or vice versa, the goal of describing the past through revenue and cost allocation is used as a justification for historical cost accounting (of which general price-level adjustments are "an extension rather than an abandonment"[25]), and the goal of describing the present through current valuation is used as a justification for specific price-level adjustments.

For example, Sprouse argues that the function of

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[22]James B. Edwards, "The Valuation Issue--Where to From Here?" The National Public Accountant (June, 1972), p. 25.

[23]W. A. Paton, "Cost and Value in Accounting," in W. A. Paton, Paton on Accounting (Ann Arbor, Michigan, 1964), p. 489.

[24]Maurice Moonitz and Louise H. Jordan, Accounting: An Analysis of Its Problems, rev. ed., Vol. 1 (Chicago, 1963), p. 169.

[25]Accounting Research Study No. 6., p. 29.

financial accounting is " ... one of providing impartial economic information for use in making decisions with respect to the future ...."[26] Assuming that this aid-in-decision-making function requires current valuation, he defends current replacement costs by appealing to the hypothesized valuation ("meaningful measurement") goal:

> ... if the primary goal of financial accounting is objectivity in meaningful measurement of income and financial position, historical costs must give way to current market values and replacement costs.[27]

Representing the historical cost viewpoint, Littleton states that "the central purpose of accounting is to make it possible for men to reach a calculated judgment of the success of the enterprise in rendering its services."[28] Implying that this requires a record of historical costs and revenues, as opposed to Sprouse, he argues that "an accounting determination of income" provides the means by which the success of the enterprise may be determined.[29] "The data of [historical] costs and revenues measure efforts and accomplishments" by which the performance of the enterprise

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[26]Robert T. Sprouse, "Historical Costs and Current Assetts--Traditional and Treacherous," The Accounting Review, XXXVIII (1963), p. 691.

[27]Ibid., p. 695.

[28]A. C. Littleton, Structure of Accounting Theory, American Accounting Association Monograph No. 6 (Ann Arbor, Michigan, 1958), p. 34.

[29]Ibid., p. 35.

is supposedly judged.[30] Both authors appeal to a psychological process--decision making or judgment formation--as the ultimate use and justification for the particular form of information presentation preferred. And each position is supported by argument, rather than by empirical evidence.

Users of Accounting Data

A second approach taken by theorists, aside from the valuation versus allocation rationalizations, is to assume that accounting data should be oriented toward certain categories of users, and then to define a particular type of data as being relevant to the needs of the hypothesized users (this approach is perhaps more common in the current replacement cost arguments).

That price-level adjustments are hypothesized rather than empirically demonstrated to provide more relevant, useful, etc. information to users is pointed out by Bierman when he states:

> Throughout the literature on price-level adjustments is the implied assumption that the information [price-level adjusted figures] will be more useful. This is not obvious.[31]

Nevertheless, the approach of assuming a prepotent group of users then justifying a particular accounting method by referring to the assumed information needs of these users persists.

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[30] Ibid.

[31] Bierman, p. 694.

For example, Edwards and Bell's argument for the use of current replacement costs is based on the premise that:

> The mass of accounting data is accumulated voluntarily by the individual firm. It is true, of course, that the demands of certain external parties influence the kind of data gathered by the business firm .... Nevertheless, the bulk of accounting data is never made available to people outside of the business firm itself. Thus it seems safe to conclude that accounting information must principally serve the functions of management.[32]

Similarly, Gynther, "A firm supporter of the use of specific indexes for the determination of profit, for balance-sheet valuations, and for day-by-day accounting and reporting purposes," argues that:

> ... if it is believed that the whole or prime purpose of accounting is to assist the entity (the firm) in its daily struggles (and that only in this way will the interests of shareholders be looked after in the long term), then it is almost certain that the use of specific indexes will be favoured, i.e. so that the physical assets of the business will be maintained during the period of changing prices.[33]

These authors justify the use of specific price indices by their belief that accounting data should be oriented toward management. An orientation toward investors rather than management has also been used to justify the use of specific price indices; Revsine and Weygandt, arguing for the use of specific indices, do so on the basis that their use provides an assumed input (the extent to which physical

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[32]Edwards and Bell, p. 4.

[33]Gynther, p. 45.

operating levels are maintained) to a decision model (prediction of cash flows) presumed to be used by investors--this accounting-data user group being implicitly defined as prepotent.

> ... insofar as an income concept reflects the maximum dividend that can be paid without impairing physical operating level, investors have some means for estimating the maximum potential future dividends emanating from the security. Thus, our criterion for evaluating alternative inflation accounting options is clear: the income determination method that best reflects the maintenance of the actual physical operating level of the firm is preferred.[34]

That an orientation toward particular user groups, with the implication that the assumed information needs of the chosen group are or should be paramount in determining a universal reporting form for accounting data, is based upon unresolved and sometimes arbitrary assumptions about who actually uses accounta data is pointed out in comments by Sterling and Mautz. Sterling states that " ... I have not been able to find decision models that specify the figures [historical costs]," which would seem to imply that in Sterling's opinion historical cost financial statements, not being required by decision models, are not used in decision making.[35] Mautz, however, responding to the "confounded assertion" that no one uses traditional financial statements, asks, "What kind of an irresponsible claim is this? Can

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[34]Revsine and Weygandt, p. 75.

[35]Robert R. Sterling, "Relevant Financial Reporting in an Age of Price Changes," The Journal of Accountancy (February, 1975), p. 47.

those who make it cite any valid evidence in support of their charge? Certainly my own experience ... contradicts this charge emphatically."[36]

Justifying the universal provision of a certain type of information because it is thought to be most relevant to specific categories of users is not the only approach taken by accounting theorists who are user-oriented. It is often argued that accounting data should be oriented not toward particular groups, but toward all potential users:

> ... this purpose [of accounting] is that of compiling and interpreting the financial data of specific business entities in such a manner as to furnish a sound guide to action by management, investors, governmental agencies, and other appropriately interested parties ....[37]

This approach also indicates an assumption about users of accounting data; however, it is that different categories of data users are undifferentiated in terms of any special information needs, and that the accounting method being recommended serves all groups equally well.

Input to Decision Models

Two aspects of a company's operations--the maintenance or erosion of its physical operating capacity, and the maintenance or erosion of its general purchasing power--have often been proposed as information that should be available

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[36]Robert K. Mautz, "A Few Words for Historical Cost," Financial Executive (January, 1973), p. 24.

[37]Paton, p. 485.

to decision makers who utilize accounting data. Normative suggestions that each type of information--the degree of maintenance of physical capacity or of purchasing power--should be provided to decision makers have been used to support different types of price index adjustments, the former supporting the use of specific price indices, and the latter supporting the use of general index adjustments. A third possibility between these two extremes also exists, that information be provided to allow calculation of the maintenance or erosion of industry purchasing power.

Maintenance of Physical Operating Capacity

It is argued that the use of current replacement costs (specific price indices) allows the calculation of a firm's current operating profit or loss as the amount by which the firm would be better or worse off at the end of a period if its assets were to be replaced at current costs (physical capacity maintained).[38] Maintenance of physical capacity is

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[38]Revsine and Weygandt, p. 74. Paul Rosenfield distinguishes between current replacement cost accounting, in which net income includes holding gains or losses on assets, and current replacement value accounting, in which holding gains and losses are not reported, and thus the balance sheet and the income statement do not articulate. Rosenfield assumes, however, that in a current replacement value system net income or loss indicates maintenance or erosion of physical capacity. See Paul Rosenfield, "Current Replacement Value Accounting--A Dead End," The Journal of Accountancy (September, 1975), pp. 66-67 and 69. Other suggested treatments of holding gains and losses under current replacement cost accounting schemes are: to treat holding

the break-even point above and below which profits or losses are determined. The underlying rationale supporting the determination or maintenance of physical capacity is that unless a company can replace its existing assets,

> ... it cannot maintain an operating position, and it cannot continue to earn income. Therefore, a charge for the use of the asset that contemplates the maintenance of an operating position should be a reasonable charge against income.[39]

Maintenance of General Purchasing Power

The use of a general price-level index allows the restatement of amounts on a company's financial statements into units (dollars) which represent equal amounts of purchasing power. In general price-level adjusted statements, maintenance of general purchasing power is the break-even point above and below which accounting profits or losses are determined.

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gains and losses as "capital items and not as items affecting profits" (Gynther, p. 79; also Donald R. Brinkman and Paul H. Prentiss, "Replacement Cost and Current-Value Measurement: How To Do It," Financial Executive (October, 1975), p. 21); to segregate "nonoperating holding gains or losses" from operating earnings" (K.D. Bowes, "The Current Value of Current-Value Accounting," Financial Executive (November, 1975), p. 24); or to split holding gains and losses into unrealized and realized portions, and to determine "current operating profit ... by deducting the current cost of related inputs from sales, and holding gains realized through use ..." (Edgar O. Edwards, "The State of Current Value Accounting," The Accounting Review (April, 1975), p. 237). Evaluations of the merits and implications of the various conceptual schemes are dependent on assumptions as to uses and users of accounting data.

[39]Charles M. Schwartz, "Inflation and Accounting Principles," The CPA Journal, XLII, p. 825.

Maintenance of Industry Purchasing Power

A third possibility for accounting exists, and that is a system in which the break-even point above and below which profits and losses are determined is the point at which the purchasing power of a firm within a particular industry is maintained.

Assumptions Underlying the Three Concepts of Capital Maintenance

Hendriksen argues that capital maintenance means "the firm should maintain its purchasing power to acquire investment goods."[40] He then elaborates upon what is meant by the "investment goods" which a company must maintain its ability (purchasing power) to acquire. These, he says, can be investment goods in general, if it is assumed firms will diversify; capital goods of the same industry, if it is assumed the firm will remain in the same industry "but possibly change the type and composition of their investment," or assets similar to those previously acquired, if it is assumed firms will reinvest in assets similar or identical to those already held.[41]

The first concept corresponds to the maintenance of general purchasing power, and the last corresponds to the maintenance of physical operating capacity. The concept

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[40] Hendriksen, p. 486.

[41] Ibid.

corresponding to an assumption of reinvestment in the same industry would be the maintenance of industry purchasing power. This is a refinement between the two extremes which is not often found in the accounting literature; it would, nevertheless, have as much validity as the other two, as all three are dependent upon arbitrary assumptions as to reinvestment activity and users' decision models. It seems possible that one reason the industry concept has been neglected is that price indices to implement the other two concepts (specific replacement and general purchasing power) are available, whereas industry price indices are not universally available.

Objections to Index Adjustments

The general source of objections to the use of either specific or general price index adjustments is the departure of the method in question from the author's expressed or implied normative preference(s). And as normative preferences can and do involve myriad variations as to what accounting is, what it does (including hypothesized decision models as well as their required inputs), and for whom, potential areas of disagreement are practically unlimited.

In addition to objections, a question regarding price level adjustments is whether they are worth the cost of providing them.

> ... are price-level restatement worth their cost? If readers can guess within small margins or error what would be the income effect of fluctuations in the exchange value of the dollar, price-level

> restated accounting reports may be unnecessary. The matter of how close readers may come in their estimates is an empirical/statistical question.[42]

Responses to the Maintenance of Physical Capacity Argument

In responding to the argument that physical capacity must be maintained before inflows are conceptualized as income, Rosenfield notes that the assumption that "the physical operating capacity of an enterprise must be kept level for it to survive in the long run has been asserted but not proved ..." and that, even if this were true, "prospering does not necessarily start only when survival is assured."[43]

A second, pragmatic response to proponents of the use of current replacement costs as indications of the maintenance of physical operating capacity is made by Chambers. He argues that current replacement cost accounting does not necessarily indicate maintenance of physical capacity:

> A simple example will show that this is not so. Suppose a firm bought a machine for $1,000 in 1971, that its expected (and actual) life was four years and that its scrap value was zero at the end of that time; and suppose that the purchase price of the asset rose by $100 each year. The depreciation charges for the four years would be $275, $300, $325 and $350; total $1,250. Yet the replacement price at the end of the fourth year is $1,400. The firm would not be able to replace the machine out of the amounts retained through depreciation charges![44]

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[42] Rosen, pp. 5-6.

[43] Rosenfield, pp. 71-72.

[44] R. J. Chambers, "NOD, COG and PuPu: See How Inflation Teases!" The Journal of Accountancy (September, 1975), p. 62.

Other Objections to Specific Index Adjustments

Probably the most frequently-voiced objection to replacement-cost accounting is that this is perceived as accounting for the hypothetical. Those voicing this criticism define costs as being historical cash outflows only; therefore, current replacement costs are perceived as outflows which hypothetically could have occurred had the assets been purchased recently, and accounting using current replacement costs becomes by definition accounting for a hypothetical situation. Mautz particularly objects to what he perceives as accounting for what did not take place:

> Does anyone obtain more useful information if a company is forced to recognize as income changes in the market value of assets which the company has no intention of selling?...
>
> The current valuer responds that the land and the investments could have been sold, that management should be held accountable for changes in value which it could have realized. How far should we indulge in such "might-have-been" accounting? Assuming management had funds available, it could have purchased additional securities when the market was low and could have sold them when the market was high. Should these possible transactions be reported also? Is this accounting? Or only wishful thinking?[45]

Costs are defined as "what has happened" in terms of transactions (cash outflows). Current replacement costs

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[45]Mautz, p. 25.

from this perspective are not another "what has happened" in terms of market value changes, but are perceived as merely one set of hypothetical alternatives of the infinite number of ways cash on hand could have been spent. "Historical cost accounting is soundly based on recognition of the effect of actual, not merely possible, transactions."[46]

Or, as Edwards summarizes the historical cost approach (and the implication that current revaluation is accounting for a hypothetical situation):

> ... let us record actual occurrences and wait with patience for those which could occur to be transacted .... Actually, revenues minus costs equals earnings. Abandoning this practice and going to revaluation leads one to something he has not actually obtained.[47]

Similarly, Stettler defines income as the difference between general price-level adjusted cash inflows and outflows.[48] With costs defined in terms of cash transactions only, current replacement accounting is not a viable alternative; income is the difference in allocated cash flows, and accounting using current replacement costs only coincidentally yields this defined income figure.

Hendriksen's criticism of current replacement-cost accounting is a variation of this theme that accounting

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[46]Ibid.

[47]Edwards, p. 23.

[48]Howard F. Stettler, "Inflation and Accounting," (Letters) The Journal of Accountancy (January, 1973), p. 34.

using replacement costs is accounting for the hypothetical, not the actual. Hendriksen's criticism of the use of current replacement costs focuses upon the firm's actual investment activities; he argues that if firms had had to pay current replacement costs for their assets, they might very well have invested in assets other than those held.

> ... current costs might not represent the current value to the enterprise. If the firm were required to pay the current costs, it might be economically advantageous to acquire other asset forms instead. The present value of the benefits to be provided by the asset may not be equal to the current or replacement cost of the asset .... For example, if the demand for a product has declined significantly, the specialized equipment required for its production has declined in service value to the firm; the depreciated cost of acquiring similar equipment is not a good measure of the value of the asset to the enterprise.[49]

Again, replacement cost accounting is seen as representing a hypothetical situation (as failing to represent accurately the firm's actual behavior, or, stated differently, as implying behavior--purchases at current prices--which did not occur). Although not specifically stated, it seems possible that these authors perceive current replacement cost accounting as violating the entity principle, in that market behavior (or prices) as well as the firm's behavior is incorporated in the accounting records.

Another objection hinges upon the assumption as to reinvestment activity thought to be implied by replacement

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[49]Eldon S. Hendriksen, Accounting Theory, rev. ed. (Homewood, Illinois, 1970), p. 268.

cost accounting. It is alleged that plant and equipment assets are seldom exactly or perhaps even approximately duplicated in actual replacement activity because of technological changes. McFarland argues that:

> Much industrial equipment is not replaced with identical or even with similar items. What happens is often better described as gradual withdrawal of capital invested in old equipment and continuing reinvestment in new and different equipment, often to produce new and different products. Many of the assets which will succeed those now owned are not even available today.[50]

His objection rests on the underlying assumption that replacement costs should be used in " ... forecasting future cash outflows which will be required to replace assets presently owned."[51] Given this assumption as to the correct use of replacement costs in decision making, McFarland's subsequent objection to their use is valid--in relation to his postulated decision model.[52]

> ... the costs that will be incurred in the more distant future when replacement of long-lived items such as buildings and equipment take place may be substantially different from present costs. Hence current replacement costs for assets other than inventory often have little usefulness for predicting the amount of funds that will be needed in the future for replacing present assets.[53]

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[50] McFarland, p. 119.

[51] Ibid.

[52] Baxter and Carrier dismiss this objection through definition. They define the excess of future replacement costs of assets with rising prices over current replacement costs as "economic expansion," rather than as replacement, thus neatly skirting the issue of the relevance of current replacement prices for predicting future cash flows. This is done despite the fact that they had previously defined cost as the effect in worsening future cash flows, p. 191.

[53] McFarland, p. 119.

Still another objection is that current replacement costs are thought to be less objective than historical costs. Rosen, paraphrasing proponents of historical cost, says "The alternatives to historical cost valuations are not objective measures and 'the cure is worse than the ailment.'"[54]

In an interesting response to this criticism, Sprouse, rather than defending the objectivity of current replacement costs, attacks what he calls the "aura of objectivity" surrounding historical costs. Discussing different results that may be obtained when accounting for identical situations using LIFO or FIFO, both "methods presumed to be covered by the umbrella of the historical cost principle," he asks if:

> It is possible that we must defend a position which might require us to explain to management that in spite of the complexities of its business transactions and the enormity of its manufacturing and marketing operations, the firm's net income depends to a significant extent on whether inventory items are issued from the bottom of the bin or issued from the top of the bin? Perhaps in his annual report to the stockholders, the president might offer the explanation that net income would have been higher or lower during the period if the bins had been stirred before materials were withdrawn.[55]

Sprouse's argument implicitly concedes the nonobjectivity of current replacement costs, but attacks the so-called

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[54] L. S. Rosen, Current Value Accounting and Price-Level Restatements (Toronto, 1972), p. 4.

[55] Sprouse, p. 691.

illusory objectivity of historical costs. Few others approach this issue in this manner; it is much more common for authors to concede the super objectivity of historical costs, but to question, as does Rosen:

> How valid is objectivity today: Once more, the degree of objectivity depends on what use is being made of the accounting information. Objectivity, in the purest sense, as an end in itself is a pointless goal for information providers.[56]

Objections to General Price-Level Adjustments

The major objection to general price-level adjustments found in the literature is that their adjusted historical costs do not necessarily represent assets' current values (current values being variously defined as current replacement costs, opportunity costs, market values, present values, or any other current cost concept favored by the author). " ... historic cost is not a reasonable indication of capital, wealth, or value ...."[57] "Balance sheets fail to reflect current values of almost all items outside the current classification."[58]

A seemingly infinite number of rewordings of this objection can be found, all stemming from their authors'

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[56]Rosen, p. 5.

[57]Ibid., p. 4.

[58]Glenn A. Welsch, Charles T. Zlatkovich, and John Arch White, Intermediate Accounting, 3rd ed. (Homewood, Illinois, 1972), p. 911.

preference for a decision model which utilizes some current cost input, and from the authors' rejection of Edwards' argument that "Recognition of the inadequacy of recorded cost as a continuous expression of 'value' should not lead to the conclusion that accounting based on cost is unsound and should be replaced."[59]

A different type of objection to general price-level adjustments is made by Gynther when he argues that support of general index adjustments of cost and revenue indicates a conscious or subconscious rejection of the going-concern concept. In his opinion, the calculation of a net income or loss amount in units of constant purchasing power (so that income and also potential dividends are defined only as amounts above a break-even position which represents the maintenance of purchasing power) represents a concern with seeing:

> ... the shareholders' interests protected in such a way that if the company ever went into liquidation, the shareholder would receive at least the same number of purchasing-power units as those he put into the company in the first place.[60]

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[59]Edwards, p. 27.

[60]Gynther, p. 46.

Possible Surrogation of Current Replacement Costs by General Price-Level Adjustments

Despite the deep-seated theoretical differences between proponents of general price-level adjustments and specific index adjustments of accounting data, it is conceded to be at least possible that in actual application the two yield substantially identical results.

> ... restatement of accounting information for changes in the general level of prices does not result in a measure of "current value" except by coincidence.[61]

> Probably the only situation where price-level restatements would be a sensible choice would be when inflation was so rapid that a strong statistical relationship developed between restated costs and such needed sums as replacement cost or resale price.[62]

> Insofar as general price levels tend to move in tandem with an entity's own unique purchasing power, general price level adjustments would also provide useful information. The reason is not because general price level adjustments are relevant per se, but rather because the general price level adjustments would tend to give the same results as do the "theoretically correct" specific adjustments. Indeed, one might argue that the entire justification for reflecting general price changes is that general and specific price levels will usually be covariant.[63]

Empirical support for evaluation of the degree to which general price-level adjustments surrogate specific

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[61] FASB Discussion Memorandum, p. 1.

[62] Rosen, p. 8.

[63] Revsine and Weygandt, p. 77.

adjustments is scanty and piecemeal, if any is provided.

Revsine and Weygandt cite examples of six indices whose price trends from 1950 to 1971 (although only observations from these two years are reported) seem to be deflationary, as opposed to the inflationary trend of prices in general.[64]

Boersema reports a coefficient of correlation of .97 between the Consumer's Price Index and Building Materials--Non-Residential, Steel and Metal Work, although it is possible for indices with nonproportional price movements to be highly correlated, as will be discussed in Chapter III.[64] He also quotes Dockweiler's conclusion that "the replacement cost balance sheet data are quite similar to the price-level balance sheet,"[65] although this is based on comparisons of case study data in which attempts to apply replacement cost adjustments in practice were described as "either impossible or highly questionable" and "rather limited."[66]

Boersema also reports a finding by Peter J. Dickerson that "general price-level asset values approximate better the current values than do the historical cost values."[67]

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[64]Boersema, p. 29.

[65]Raymond C. Dockweiler, "The Practicability of Reporting Historical Cost, Adjusted Historical Cost, and Replacement Cost Data in a Single Set of Financial Statements: A Case Study" (unpublished PhD dissertation, University of Illinois, 1969), quoted in Boersema, p. 29.

[66]Dissertation Abstracts, 1969, p. 862-A.

[67]Peter J. Dickerson, Business Income--A Critical Analysis, 1965, quoted in Boersema, p. 29.

This study is an attempt to lessen the dearth of empirical evidence bearing on the issue of whether general price level adjustments surrogate specific index adjustments.

Reinvestment Activity of Firms

A second issue to be examined empirically is the extent to which differential reinvestment activity (homogeneous or heterogeneous) of firms affects the surrogation of price movements of the groups of specific assets by the GNP Deflator. It is contended that the assumption of homogeneous reinvestment activity underlies the use of specific price index adjustments, and the assumption of heterogeneous reinvestment activity underlies the use of general index adjustments.[68]

The question of how firms actually diversify is an empirical one. Short describes possible types of merger activity, or diversification of a firm's assets. Horizontal mergers unite like enterprises and vertical mergers unite firms "having a supplementary relationship," the resulting enterprises dealing with one, or more than one but related products. Conglomerate mergers take place when firms diversify into unrelated areas.[69]

Revsine and Weygandt argue that most firms (all but a

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[68] Revsine and Weygandt, p. 77; also Hendriksen, p. 486.

[69] Robert A. Short, Business Mergers: How and When to Transact Them (Englewood Cliffs, N. J., 1967), p. 12.

few highly diversified conglomerates) will diversify homogeneously;[70] Hendriksen, on the other hand, believes that the assumption of future reinvestment in similar assets " ... is probably the least relevant. In a dynamic economy, firms are continually changing the composition of their investments."[71]

Haley and Schall argue against the concept of purposeful diversification as an objective of firms. They note that " ... if the firm has a portfolio problem of any significance, then by implication the individual shareholders must not be able to diversify effectively through purchases of securities of different firms."[72] Although acknowledging that firms owned and managed by only a few individuals might provide benefits to their owners through diversification, they nevertheless argue that this is not the usual situation, and that " ... we believe diversification by large firms would not provide appreciable benefits for most shareholders."[73]

Regardless of how or if firms purposefully diversify, the question of how firms reinvest becomes an empty one, in terms of its bearing upon arguments supporting the use of specific or general price level adjustments, if homogeneous

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[70]Revsine and Weygandt, pp. 77-78.

[71]Hendriksen, p. 486.

[72]Charles W. Haley and Lawrence D. Schall, The Theory of Financial Decisions (New York, 1973), p. 359.

[73]Ibid., p. 360.

and heterogeneous groups of assets are not significantly different in the degree to which their averaged price movements are surrogated by price movements of the GNP Deflator. This study addresses the issue of the significance of differential surrogation of homogeneous and heterogeneous groups of price indices by the GNP Deflator.

Summary

Theoretical arguments which have been made for the use of general price-level adjustments and for the use of current replacement-cost adjustments in financial statements are summarized in this chapter; assumptions from which the theoretical arguments were logically derived are also discussed. Arguments that the two approaches yield (do not yield) substantially identical results are presented. The purpose of the study is to evaluate empirically the surrogation of price movements in individual indices by the GNP Deflator (the evaluation to include assumptions as to homogeneous or heterogeneous reinvestment activity of firms) as a preliminary step toward answering the question of whether general price-level and current replacement-cost financial statements are in fact substantially identical.

CHAPTER III

A MEASURE OF SURROGATESHIP FOR ACCOUNTING PURPOSES

The property to be captured in a measure of the surrogateship of one index for another for accounting purposes is the relative convergence of percentage price changes in the indices. A measure of relative convergence of price changes and the rationale underlying the measure are discussed in this chapter. In addition, an extended example is presented to illustrate the computational process.

The S Value

To determine the degree of association between specific indices and the general index, the following variables will be computed for each index series.

$$S = \sum_{t=1}^{n-1} \left| (ln_{it} - ln_{it+1}) - (ln_{gt} - ln_{gt+1}) \right|$$

ln_{it} = logarithm of index i at time t

ln_{gt} = logarithm of the GNP Deflator at time t

n = number of observations

The approach of the computed value S toward zero represents the similarity in underlying percentage changes of the indices, and therefore the substitutability of the GNP

Deflator for a particular index. This is explained as follows.

As price-level adjustments to accounting data are made using ratios of price indices, a specific price index would be perfectly surrogated by the GNP Deflator if proportionate price changes occurred in each. For example, it will be assumed that the Time 1 cost of Asset X is to be converted to Time 2 dollars, and the price indices of Asset X and the GNP Deflator are as follows:

	GNP Deflator	Specific Price Index of Asset X
Time 1	100	140
Time 2	120	168

The specific index for Asset X is perfectly surrogated by the GNP Deflator, the conversion factor using the specific price index for Asset X being 168/140 or 1.2, which is equal to the conversion factor of 120/100 or 1.2 obtained from using the GNP Deflator. The price of the specific asset and prices in general increased by 20 percent between Time 1 and Time 2.

"Equal changes on a logarithmic scale represent equal percentage changes in the variable."[1] Therefore, since equal percentage changes in two indices is the criterion for their perfect substitutability, equal changes in logarithms will also signify perfect substitutability. To continue

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[1]Ronald E. Frank, "Use of Transformations," Multivariate Analysis in Marketing: Theory and Application, ed. David A. Aaker (Belmont, California, 1971), p. 47.

with the previous example:

	GNP Deflator	Specific Price Index of Asset X
Time 1	ln 100=4.6052	ln 140=4.9416
Time 2	ln 120=4.7875	ln 168=5.1239

First difference in logarithms of
GNP Deflator = 4.7875 - 4.6052 = .1823

First difference in logarithms of
specific price index of Asset X = 5.1239 - 4.9416 = .1823.

The equal percentage changes, 20 percent, in the underlying variables are represented by equal changes, .1823, in the logarithms of the variables.

Since percentage changes in the indices were identical, the difference between the first differences of the logarithms of the indices was zero: .1823 - .1823 = 0. A small divergence of percentage changes in the underlying indices would have been represented by a near-zero difference in first differences of logarithms; as percentage changes in the indices being compared converge, the difference between first differences of their logarithms will approach zero.

The formula on page 43 extends this procedure. Rather than finding 1 difference between 2 observations, n-1 differences between n observations are calculated and their absolute values summed. Summing absolute values avoids the situation where positive and negative differences could offset each other; otherwise, the total could sum to zero when underlying percentage changes were not equal. The nearer the sum is to zero, the closer are the price movements of the two indices being compared.

A Discussion of the S Value

One characteristic of the S value is that it is a descriptive, rather than an inferential statistic. A calculated S value of a sample or subset of a sample of indices is one of the ways in which the sample may be described, just as it might be described as having a particular median. The S value of a sample does not lead mathematically to inferences about the population; it simply describes the sample. As this study is a simulation, however, and as inferences from simulations to real-world situations must be based on analogy rather than upon mathematically-supportable generalizations, this characteristic does not particularly limit conclusions which may be drawn as to the argument regarding surrogation of indices.

A second characteristic of the S value is that its interpretation is not intuitively obvious. The interpretation of, for example, regression coefficients is that they indicate changes in one variable associated with unit changes in a second variable. S values, however, do not lend themselves to similar conceptualization. They are defined, and support for the definition rests on the logic underlying the computations, rather than on an intuitive comprehension of how the S values measure surrogateship.

Correlation of Indices: Not A Measure of Surrogateship

It has been suggested or implied that correlations of indices indicate surrogateship of the indices for accounting purposes. Boersema was previously quoted citing a correlation coefficient of .97 between price indices as partial support of his contention that general price-level adjusted costs are surrogates for current replacement costs.[2] That correlations imply surrogateship is also suggested in the following quotation from Accounting Research Study No. 6:

> There may, however, be a high degree of correlation between two indexes so that the price movements measured by an index for one segment of the economy may approximate price movements in another sector or in the economy as a whole. When this correlation exists, the index for one segment of the economy may be used to estimate relative price changes in the other sector, or in the economy as a whole, when the desired index is not available.[3]

Correlations, however, indicate association between variables; the squared correlation coefficient indicates the proportion of variance in one variable that is explained by a second variable. In an accounting context, price indices are perfect surrogates for one another not if changes in one index can be completely explained by changes in another, but only if percentage price changes in the two are equal. Any two linear series, for example, will be perfectly

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[2]Boersema, p. 29.

[3]Accounting Research Study No. 6, p. 69.

correlated, as changes in one series will completely explain (account for) changes in the second series, although proportionate percentage changes in the series will be equal only by coincidence. The following example illustrates this possibility:

TABLE I

ILLUSTRATION OF UNEQUAL PERCENTAGE CHANGES IN PERFECTLY CORRELATED SERIES

Time	Series 1	% Increase	Series 2	% Increase
1	80		140	
2	85	6.25%	142	1.43%
3	90	5.88%	144	1.41%
4	95	5.56%	146	1.39%
5	100	5.26%	148	1.37%

Five point changes in Series 1 completely explain all changes (two points) in Series 2, so the two series are perfectly correlated. Yet proportionate percentage changes in the two series are not equal, and in an accounting context the series are not perfect surrogates. A high correlation coefficient is a necessary, yet not sufficient, condition for the surrogation of one series by another.

Comparison of Individual Indices to the GNP Deflator: An Example

An extended example is presented here to illustrate the process of computing S values. The following series of observations of five fictitious price indices will be compared to a fictitious GNP Deflator.

TABLE II

FICTITIOUS PRICE SERIES: GNP DEFLATOR AND INDIVIDUAL INDICES

Time	GNP Deflator	A	B	C	D	E
1	100	96	100	86	101	177
2	97	97	109	94	102	161
3	97	95	104	118	104	149
4	94	97	100	120	105	127
5	96	97	103	130	105	127

The first step in the computational process is to convert all observations to natural logarithms.

TABLE III

LOGARITHMS OF OBSERVATIONS OF
FICTITIOUS PRICE SERIES

Time	GNP Deflator	A	B	C	D	E
1	4.6052	4.5643	4.7005	4.4543	4.6151	5.1761
2	4.5747	4.5747	4.6913	4.5433	4.6250	5.0814
3	4.5747	4.5539	4.6444	4.7707	4.6444	5.0039
4	4.5433	4.5747	4.6052	4.7875	4.6540	4.8442
5	4.5643	4.5747	4.6347	4.8675	4.6540	4.8442

Next, first differences of logarithms are computed, these being, for each series, the logarithm of Time 1 - the logarithm of Time 2, Time 2 - Time 3, etc.

TABLE IV

FIRST DIFFERENCES OF LOGARITHMS OF
OBSERVATIONS OF FICTITIOUS
PRICE SERIES

Time	GNP Deflator	A	B	C	D	E
1-2	.0305	-.0104	.0092	-.0890	-.0099	.0947
2-3	-0-	.0208	.0469	-.2274	-.0194	.0775
3-4	.0314	-.0208	.0392	-.0168	-.0096	.1597
4-5	-.0210	-0-	-.0295	-.0800	-0-	-0-

The third step in computing the S values is to subtract the first difference of each individual series from the first difference of the GNP Deflator for each time period. So for the time period 1-2, the first difference of the logarithms of the GNP Deflator minus the first difference of the logarithms of Index A is .0305 - (-.0104) = .0409; for Series B it is .0305 - .0092 = .0213, etc.

TABLE V

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF INDIVIDUAL SERIES

Time	A	B	C	D	E
1-2	.0409	.0213	.1195	.0404	-.0642
2-3	-.0208	-.0469	.2274	.0194	-.0775
3-4	.0552	-.0078	.0482	.0410	-.1283
4-5	-.0210	.0085	.0590	-.0210	-.0210

Absolute values of the differences in first differences of logarithms of the GNP Deflator and logarithms of the individual series are then summed, and these totals are the S values obtained when each individual index is compared to the GNP Deflator. The use of absolute values guarantees that all S values will be positive or zero.

TABLE VI

SUMS OF ABSOLUTE VALUES OF DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF INDIVIDUAL SERIES

Time	A	B	C	D	E
1-2	.0409	.0213	.1195	.0404	.0642
2-3	.0208	.0469	.2274	.0194	.0775
3-4	.0552	.0078	.0482	.0410	.1283
4-5	.0210	.0085	.0590	.0210	.0210
S =	.1379	.0845	.4541	.1218	.2910

In the example, the S value when compared to the GNP Deflator was .1379 for Index A; .0845 for Index B; .4541 for Index C; .1218 for Index D; and .2910 for Index E. Index B had the smallest S value, which indicates that the percentage price changes in this index most closely approximated the percentage price changes in the GNP Deflator; this does not necessarily mean, however, that the GNP Deflator surrogated Index B. The problem of determining the point at which surrogation is assumed to occur will be discussed in Chapter IV.

Summary

The measure of relative convergence of price indices (which indicates relative surrogateship for accounting

purposes) used in the study, called an S value, and the rationale underlying the measure are developed in this chapter. Characteristics of the S value, a brief discussion of the reason correlation coefficients do not measure surrogateship, and an example of the calculation of the S value are also presented.

CHAPTER IV

OPERATIONAL DEFINITIONS OF HOMOGENEOUS GROUPS, HETEROGENEOUS GROUPS, AND SURROGATESHIP

Operational definitions of homogeneous and heterogeneous groups of indices, and an operational definition of surrogateship are presented in this chapter. These are subsequently used in evaluating the argument that homogeneous and heterogeneous groups of indices are differentially surrogated by the GNP Deflator. Also presented is a continuation of the example from Chapter III, in which the procedure used to determine homogeneous and heterogeneous groups is illustrated.

Development of Homogeneous Groups

Homogeneous indices are operationally defined as being those whose price movements are most like, with relative likeness of percentage price changes measured by using S values.

In the development of homogeneous groups, every index was compared to every other index. The index most like each original index in price behavior was determined; groups of every two most like indices were then averaged, and each

new, averaged index of the price behavior of two assets was compared to the GNP Deflator. This iterative process of determining then including in the group average the most like asset to each asset grouping continued, with group averages being compared to the GNP Deflator after each addition, until surrogation of most of the homogeneous groups of indices by the GNP Deflator occurred.

This process is illustrated in a continuation of the example from Chapter III. First, every index is to be compared to every other index in terms of price behavior. So A is compared to B, C, D, and E; B is compared to A, C, D, and E; and so on, so that, in this example, 5 groups of 2 homogeneous indices would eventually be determined. As the comparison process is identical, the comparison of only Index A to the other four indices to determine the most homogeneous group of two indices containing A will be shown.

First differences of the logarithms of the indices have already been computed in Table IV. As the purpose of these computations is to determine the index most like Index A, rather than to determine the index most like the GNP Deflator, the first difference of each individual series except Index A is subtracted from the first difference of Index A for each time period. For example, the difference in first differences of logarithms of A and B for Time 2-3 is .0208 - .0469 = -.0261. This is shown in Table VII.

TABLE VII

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF INDEX A AND LOGARITHMS OF OTHER SERIES

Time	B	C	D	E
1-2	-.0196	.0786	-.0005	-.1051
2-3	-.0261	.2482	.0402	-.0567
3-4	-.0600	-.0040	-.0112	-.1805
4-5	.0295	.0800	-0-	-0-

S values are then obtained by summing absolute values of the differences in first differences of the logarithms of Index A and the logarithms of the other series.

TABLE VIII

SUMS OF ABSOLUTE VALUES OF DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF INDEX A AND LOGARITHMS OF OTHER PRICE SERIES

Time	B	C	D	E
1-2	.0196	.0786	.0005	.1051
2-3	.0261	.2482	.0402	.0567
3-4	.0600	.0040	.0112	.1805
4-5	.0295	.0800	-0-	-0-
S =	.1352	.4108	.0519	.3423

Index D had the smallest S value when compared to Index A, which means D is the asset most like A in terms of percentage price changes. By definition, then, group A-D is the most homogeneous group of two indices in the sample when Index A is used as the starting point.

Observations from Indices A and D (and the other four groups of two homogeneous indices which would be determined in the same manner) are then averaged, and a new index, which is the average of the combined homogeneous indices, is compared to the GNP Deflator to see whether or not surrogation of the averaged price movements of each group of two by the GNP Deflator occurs.

TABLE IX

AVERAGES OF OBSERVATIONS OF INDICES A AND D AND LOGARITHMS OF THE AVERAGES

Time	A	D	A-D Averages	Logarithms of Averages
1	96	101	98.5	4.5901
2	97	102	99.5	4.6002
3	95	104	99.5	4.6002
4	97	105	101.0	4.6151
5	97	105	101.0	4.6151

First differences in the logarithms of the new A-D Index are computed as in Table IV; first differences in the logarithms of the GNP Deflator are taken from Table IV.

TABLE X

FIRST DIFFERENCES OF LOGARITHMS OF OBSERVATIONS OF GNP DEFLATOR AND A-D AVERAGES

Time	GNP Deflator	A-D Averages
1-2	.0305	-.0101
2-3	-0-	-0-
3-4	.0314	-.0149
4-5	-.0210	-0-

The computation of differences in first differences of the logarithms of the GNP Deflator and the logarithms of the A-D Averages is analagous to that of Table IV.

TABLE XI

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF A-D AVERAGES, AND SUMS OF ABSOLUTE VALUES OF THE DIFFERENCES

Time	A-D Averages	Absolute Values of A-D Averages
1-2	.0406	.0406
2-3	-0-	-0-
3-4	.0463	.0463
4-5	-.0210	.0210
		S = .1079

The S value representing comparison of the index group A-D to the GNP Deflator is .1079. S values for each of the other four groups of homogeneous indices would also be obtained, and these would be used to determine which of the five groups (if any) were surrogated by the GNP Deflator. Determination of the S value which signifies the cut-off point at which surrogation is presumed to occur will be discussed later. It will be assumed arbitrarily in this example that the cut-off point is .0400 (groups with S values above .0400 are not surrogated, and those with S values of .0400 or below are surrogated); if this is the case, surrogation by the GNP Deflator of the homogeneous index group A-D does not occur.

Next in the iterative process is the addition of a third index to each homogeneous group of two. This is done by comparing (using S values) the index composed of the averaged observations of each homogeneous group of two to all other individual indices, to find the third index which most closely approximates the price movements of the averaged homogeneous groups. When the third homogeneous asset has been determined for each group, a new index, in which observations from all three indices in each group are averaged, is compared to the GNP Deflator to see whether surrogation occurs. This process is presented below.

TABLE XII

PRICE SERIES: A-D AVERAGES AND OTHER INDIVIDUAL SERIES

Time	A-D Averages	B	C	E
1	98.5	110	86	177
2	99.5	109	94	161
3	99.5	104	118	149
4	101.0	100	120	127
5	101.0	103	130	127

TABLE XIII

LOGARITHMS OF OBSERVATIONS OF A-D AVERAGES AND OTHER INDIVIDUAL SERIES

Time	A-D Averages	B	C	E
1	4.5901	4.7005	4.4543	5.1761
2	4.6002	4.6913	4.5433	5.0814
3	4.6002	4.6444	4.7707	5.0039
4	4.6151	4.6052	4.7875	4.8442
5	4.6151	4.6347	4.8675	4.8442

TABLE XIV

FIRST DIFFERENCES OF LOGARITHMS OF OBSERVATIONS OF A-D AVERAGES AND OTHER INDIVIDUAL SERIES

Time	A-D Averages	B	C	E
1-2	-.0101	.0092	-.0890	.0947
2-3	-0-	.0469	-.2274	.0775
3-4	-.0149	.0392	-.0168	.1597
4-5	-0-	-.0295	-.0800	-0-

TABLE XV

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF A-D AVERAGES AND LOGARITHMS OF OTHER INDIVIDUAL SERIES

Time	B	C	E
1-2	-.0193	.0789	-.1048
2-3	-.0469	.2274	-.0775
3-4	-.0541	.0019	-.1746
4-5	.0295	.0800	-0-

TABLE XVI

SUMS OF ABSOLUTE VALUES OF DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF A-D AVERAGES AND LOGARITHMS OF OTHER INDIVIDUAL SERIES

Time	B	C	E
1-2	.0193	.0789	.1048
2-3	.0469	.2274	.0775
3-4	.0541	.0019	.1746
4-5	.0295	.0800	-0-
S =	.1498	.3882	.3569

B is most like group A-D. The index group A-D-B is therefore the most homogeneous group of three indices with Index A used as the starting point. Four other homogeneous groups of three indices would also have been determined, and the averages of the groups of three then compared to the GNP Deflator to see how many (if any) of the groups of three indices are surrogated. This comparison process is shown only for group A-D-B.

TABLE XVII

AVERAGES OF OBSERVATIONS OF INDICES A, D, AND B AND LOGARITHMS OF THE AVERAGES

Time	A	D	B	Averages	Logarithms of Averages
1	96	101	110	102.33333	4.6282
2	97	102	109	102.66667	4.6315
3	95	104	104	101.00000	4.6151
4	97	105	100	100.66667	4.6118
5	97	105	103	101.66667	4.6217

TABLE XVIII

FIRST DIFFERENCES OF LOGARITHMS OF OBSERVATIONS OF GNP DEFLATOR AND A-D-B AVERAGES

Time	GNP Deflator	A-D-B Averages
1-2	.0305	-.0033
2-3	-0-	.0164
3-4	.0314	.0033
4-5	-.0210	-.0099

TABLE XIX

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF A-D-B AVERAGES, AND SUMS OF ABSOLUTE VALUES OF THE DIFFERENCES

Time	A-D-B Averages	Absolute Values of A-D-B Averages
1-2	.0338	.0338
2-3	-.0164	.0164
3-4	.0281	.0281
4-5	-.0111	.0111
		S = .0894

The S value of group A-D-B compared to the GNP Deflator is .0894; if the cut-off point for surrogation is .0400, surrogation of the homogeneous group A-D-B does not occur.

Next the A-D-B averages would be compared to indices C and E to determine the fourth homogeneous asset, the group of four indices compared to the GNP Deflator to see whether surrogation occurred yet, and so on, until surrogation of most groups had occurred.

Development of Heterogeneous Groups

Heterogeneous groups of indices are defined with an implicit assumption that firms diversify purposefully. Reasons often cited for a firm to expand into new areas are to stabilize profits or to hedge against recessions. These imply not random diversification into unrelated areas, but diversification into areas which are inversely related to the original business activities. Indices are defined as being the most heterogeneous combination not if their price movements are most unlike, but if their averaged price behavior most closely approximates the behavior of the GNP Deflator (which conforms to the idea of purposeful diversification). Heterogeneous assets' price behavior is, as it were, opposite and equidistant from the behavior of the general index. Operationally, heterogeneous groups of indices are defined as the combination which, when the original index (indices) in each group is (are) combined with every other index and the averaged price behavior of

each new group compared to the GNP Deflator, produces a lower S value than any other combination of the same number which includes the original index (indices).

To continue with the previous example, Index A will again be used as the starting point (actually 5 groups of heterogeneous indices would be developed), for the development, now, of heterogeneous groups.

New indices, composed of averaged observations of Index A and every other index, are first computed.

TABLE XX

AVERAGED OBSERVATIONS OF INDEX A AND OTHER INDIVIDUAL SERIES

Time	A-B Averages	A-C Averages	A-D Averages	A-E Averages
1	103.0	91.0	98.5	136.5
2	103.0	95.5	99.5	129.0
3	99.5	106.5	99.5	122.0
4	98.5	108.5	101.0	112.0
5	100.0	113.5	101.0	112.0

Logarithms of the averages are then taken, and first differences of the logarithms of the averages series compared to first differences of the GNP Deflator.

TABLE XXI

LOGARITHMS OF AVERAGED OBSERVATIONS OF INDEX A AND OTHER INDIVIDUAL SERIES

Time	A-B Averages	A-C Averages	A-D Averages	A-E Averages
1	4.6347	4.5109	4.5901	4.9163
2	4.6347	4.5591	4.6002	4.8598
3	4.6002	4.6681	4.6002	4.8040
4	4.5901	4.6868	4.6151	4.7185
5	4.6052	4.7318	4.6151	4.7158

TABLE XXII

FIRST DIFFERENCES OF LOGARITHMS OF AVERAGED OBSERVATIONS OF INDEX A AND OTHER INDIVIDUAL SERIES, AND OF THE GNP DEFLATOR

Time	GNP Deflator	A-B Averages	A-C Averages	A-D Averages	A-E Averages
1-2	.0305	-0-	-.0482	-.0101	.0565
2-3	-0-	.0345	-.1090	-0-	.0558
3-4	.0314	.0101	-.0187	-.0149	.0855
4-5	-.0210	-.0151	-.0450	-0-	-0-

TABLE XXIII

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF AVERAGED SERIES

Time	A-B Averages	A-C Averages	A-D Averages	A-E Averages
1-2	.0305	.0787	.0406	-.0260
2-3	-.0345	.1090	-0-	-.0558
3-4	.0213	.0501	.0463	-.0541
4-5	-.0059	.0240	-.0210	-.0210

TABLE XXIV

SUMS OF ABSOLUTE VALUES OF DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF AVERAGED SERIES

Time		A-B Averages	A-C Averages	A-D Averages	A-E Averages
1-2		.0305	.0787	.0406	.0260
2-3		.0345	.1090	-0-	.0558
3-4		.0213	.0501	.0463	.0541
4-5		.0059	.0240	.0210	.0210
	S =	.0922	.2618	.1079	.1569

The S value of group A-B is the lowest at .0922. Index B is the index most heterogeneous to Index A, in that the averaged price behavior of these two indices most closely approximates the GNP Deflator. Again, with the cut-off point for surrogation assumed to be .0400, surrogation of the heterogeneous group A-B by the GNP Deflator does not occur.

In the next iteration, observations from Indices A and B are averaged with every other index, then sums of the absolute values of the differences between first differences of the logarithms of the GNP Deflator and the averaged indices are compared. Again, the lowest S value represents the most heterogeneous group of three indices, with the

group A-B taken as the starting point.

TABLE XXV

AVERAGED OBSERVATIONS OF INDICES A, B, AND EACH OTHER INDIVIDUAL SERIES

Time	A-B-C Averages	A-B-D Averages	A-B-E Averages
1	97.33333	102.33333	127.66667
2	100.00000	102.66667	122.33333
3	105.66667	101.00000	116.00000
4	105.66667	100.66667	108.00000
5	110.00000	101.66667	109.00000

TABLE XXVI

LOGARITHMS OF AVERAGES OBSERVATIONS OF INDICES A, B, AND EACH OTHER INDIVIDUAL SERIES

Time	A-B-C Averages	A-B-D Averages	A-B-E Averages
1	4.5781	4.6282	4.8494
2	4.6052	4.6315	4.8067
3	4.6603	4.6151	4.7536
4	4.6603	4.6118	4.6821
5	4.7005	4.6217	4.6913

TABLE XXVII

FIRST DIFFERENCES OF LOGARITHMS OF AVERAGED OBSERVATIONS OF INDICES A, B, AND EACH OTHER INDIVIDUAL SERIES, AND OF THE GNP DEFLATOR

Time	GNP Deflator	A-B-C Averages	A-B-D Averages	A-B-E Averages
1-2	.0305	-.0271	-.0033	.0427
2-3	-0-	-.0551	.0164	.0531
3-4	.0314	-0-	.0033	.0715
4-5	-.0210	-.0402	-.0099	-.0092

TABLE XXVIII

DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF AVERAGED SERIES

Time	A-B-C Averages	A-B-D Averages	A-B-E Averages
1-2	.0576	.0338	-.0122
2-3	.0551	-.0164	-.0531
3-4	.0314	.0281	-.0401
4-5	.0192	-.0111	-.0118

TABLE XXIX

SUMS OF ABSOLUTE VALUES OF DIFFERENCES IN FIRST DIFFERENCES OF LOGARITHMS OF GNP DEFLATOR AND LOGARITHMS OF AVERAGED SERIES

Time		A-B-C Averages	A-B-D Averages	A-B-E Averages
1-2		.0576	.0338	.0122
2-3		.0551	.0164	.0531
3-4		.0314	.0281	.0401
4-5		.0192	.0111	.0118
	S =	.1633	.0894	.1172

Group A-B-D, with the lowest S value, is the most heterogeneous group of three indices which includes A and B as the original two. Four other groups of three would also have been developed; surrogation of this particular group still has not occurred, as the S value of A-B-D is above .0400.

The iterative process of forming heterogeneous groups would be continued, until most of the groups were surrogated by the GNP Deflator.

An Operational Definition of Surrogateship

One of the issues to be resolved in the present study is the problem of defining surrogateship--at what point does the GNP Deflator surrogate specific indices? This issue was resolved arbitrarily. Surrogation is assumed to take place if the S value obtained when the GNP Deflator is

compared to the particular index in question is as low as or lower than the S value obtained when the GNP Deflator is compared to an index consisting of the averaged values of all indices in the study. This value, with all indices weighted equally (as are indices in the individual groups in the study) is .28759.

Implications of the Operational Definition of Surrogateship

Since individual price movements determine the average (general) price movement in the economy, it would not seem unreasonable that a sample encompassing a significant proportion (13.6%) of the wholesale price index of the Bureau of Labor Statistics be assumed to be surrogated by the GNP Deflator.[1] On the other hand, the effects of movements in individual price indices are not weighted equally in the GNP Deflator, and they are in the present study. For this reason, the S value was computed also for a weighted average (by relative weights in the Wholesale Price Index as of December, 1961) of all indices as compared to the GNP Deflator. Interestingly, the S value obtained, .36108, was slightly higher than that obtained by using equal weights (use of equal weights provides a more rigorous cut-off point). The closeness of the two would seem to indicate that the assumption of equal weights in the study does not

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[1]From Table 3-2, Stigler and Kindahl, pp. 24-26.

cause serious distortion.

One of the limitations of the study mentioned in Chapter I is the fact that surrogateship is arbitrarily defined, with no attempt made to support behaviorally the contention that the averaged price behavior of all indices was surrogated by the GNP Deflator. It is intuitively appealing that the S value obtained when the maximum possible diversification (into 62 areas) had occurred is a conservative estimate of the point at which surrogateship occurs; this is, however, not an empirically-supported assumption.

The operational definition of surrogateship is also limited in that only differences between quarters, rather than between longer time periods, are tested. It is possible that differences in price behavior of indices between quarters would be in themselves small, but that the differences would all occur in the same direction, and the cumulative effect over a longer period of time be large. In this case, surrogation as between quarters, or even between years might occur, yet surrogation over longer periods not occur.

Summary

Homogeneous and heterogeneous groups are operationally defined in this chapter, homogeneous indices being those whose price movements are most like, and heterogeneous indices being the combination whose averaged price behavior most closely approximates the price behavior of the GNP Deflator. The example from Chapter III is extended to

illustrate the development of homogeneous and heterogeneous groups. Surrogateship for accounting purposes is also operationally defined, and some of the implications and limitations of the operational definition are discussed.

CHAPTER V

RESULTS OF STUDY

Empirical evidence generated from the index sample is used to evaluate the original arguments of whether the general price index surrogates specific price indices, and whether homogeneous and heterogeneous groups of indices are significantly different in the degree to which they are surrogated by the GNP Deflator.

The Sample

The sample consisted of sixty-two indices from the Bureau of Labor Statistics wholesale price series, quarterly observations from the series having been taken for the ten year period 1957 through 1966. These commodities and identifying numbers assigned to the commodities are listed in Table XXX.

The indices tested were those used in a study of the quality of price information by Stigler and Kindahl.[1] In discussing criteria affecting their own selection of indices, Stigler and Kindahl first list factors which affect whether a commodity is included in the Bureau of Labor Statistics

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[1]Stigler and Kindahl, pp. 22-23.

TABLE XXX

A LIST OF PRODUCT INDICES TESTED AND INDEX IDENTIFICATION NUMBERS

Index No.	Product Indices
1	Carbon Steel, Sheet and Strip--Cold Rolled
2	Carbon Steel, Sheet and Strip--Hot Rolled
3	Tinplate
4	Carbon Steel Plates
5	Carbon Steel, Bars and Rods
6	Carbon Steel, Plain Pipe
7	Carbon Steel, Wire
8	Stainless Steel, Sheet and Strip
9	Alloy Steel Bars--Hot and Cold Rolled
10	Aluminum, Ingot and Shot
11	Aluminum, Sheet and Strip
12	Aluminum, Wire and Cable
13	Copper Ingot
14	Copper, Pipe and Tubing
15	Copper, Wire and Cable--Bare
16	Copper, Insulated Wire
17	Copper, Magnet Wire
18	Zinc Products
19	Brass, Bars and Rods
20	Regular Gasoline
21	Diesel and Distillate Fuel No. 2
22	Residual Fuel Oil No. 6

TABLE XXX (Continued)

Index No.	Product Indices
23	Coal, Bituminous
24	Passenger Car Tires
25	Truck and Bus Tires
26	Synthetic Rubber--SBR, Hot, Cold
27	Neoprene
28	Rubber Belting, Industrial
29	Paper: Book, Magazine, Etc.
30	Newsprint
31	Coarse Paper and Bags, Kraft Papers
32	Paperboard--Unfabricated
33	Paper Boxes and Shipping Containers
34	Bond Paper
35	Sulfuric Acid--Bulk
36	Caustic Soda--Liquid
37	Titanium Dioxide
38	Chlorine--Bulk
39	Regular Oxygen
40	Ammonia
41	Acetone
42	Acetylene
43	Benzene, Benzol
44	Styrene Monomer
45	Ethyl Alcohol

TABLE XXX (Continued)

Index No.	Product Indices
46	Methyl Alcohol
47	Glycerine--Natural and Synthetic
48	Phthalic Anhydride
49	Phenol
50	Polyethylene
51	Polystyrene
52	Polyvinyl Chloride
53	Phenolic Resins, Plastics
54	Antibiotics
55	Tranquilizers
56	Paint
57	Portland Cement
58	Plate Glass
59	Safety Glass and Window Glass
60	Electric Motors--Excluding DC
61	Plywood
62	Car Flooring

series. These factors are:

1. Importance, measured by value;
2. Availability of price data;
3. Representativeness--a commodity is preferred if its price history probably represents that of other commodities;
4. Persistent specifiability--a commodity which cannot be described or for which the description will not remain essentially unchanged for a time, is not included. There are exceptions, such as various types of machinery.
5. Historical inertia--a price series, once included, is generally kept until prices become difficult to collect.[2]

Noting that the Bureau of Labor Statistics wholesale price series is not a "sampling of a formal statistical variety" of the universe of wholesale prices, but rather the product of the criteria listed above, Stigler and Kindahl then list additional criteria affecting their selection of indices from the wholesale price series:

1. We ... pay special attention to the areas in which the charge of inflexible prices has been heard most frequently: ferrous and nonferrous metals, chemicals, and drugs. Accordingly, we omit certain areas in which no such charge seems important (foods generally and certain textiles) or where price behavior reflects different forces (charges by public utilities).
2. The BLS commodity list is compelled by the nonstandardization and rapid change in product characteristics to omit or under-represent most machinery, construction, electronic goods, and custom work. We go even further in excluding almost all such commodities because the problem of measuring change in the quality of products is the major unsolved task of all price collection ....[3]

The nonrandomness of the sample is a serious limitation of the study, although at best a random sample could have

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[2] Ibid.

[3] Ibid., p. 23.

been representative of the Bureau of Labor Statistics series, which is itself a nonrandom sample of the universe of all wholesale prices.

Results of the Study

Comparison of Individual Indices to the GNP Deflator

S values were computed for every individual index as compared to the GNP Deflator, using forty observations (quarterly observations for the ten-year period) from each of the sixty-two indices. The base year for the indices was 1964.

Results of this comparison are shown in Table XXXI. If surrogation is assumed to occur when the S value is .28759 or below, 21 of the 62 indices (34%) were initially surrogated by the GNP Deflator (before they were combined into homogeneous or heterogeneous groups).

Combination of Indices into Homogeneous and Heterogeneous Groups

The indices were then combined into homogeneous and heterogeneous groups, using the methodology described in Chapter IV. S values of the combined groups as compared to the GNP Deflator are presented in Appendix A.

Index numbers identifying the indices which comprise the groups are presented in Appendix B. Some duplication of groups occurred, more often with the formation of the

TABLE XXXI

S VALUES OBTAINED WHEN INDIVIDUAL INDICES WERE COMPARED TO THE GNP DEFLATOR

Index No.	S Value	Index No.	S Value
1	0.26095	22	0.97064
2	0.26636	23	0.78638
3	0.24979	24	0.78663
4	0.25871	25	0.82959
5	0.27075	26	0.22980
6	0.28936	27	0.17981
7	0.24406	28	0.33402
8	0.39921	29	0.20812
9	0.23056	30	0.21621
10	0.63236	31	0.71525
11	0.57374	32	0.33160
12	0.93797	33	0.49119
13	1.05713	34	0.22749
14	1.42633	35	0.28630
15	0.87555	36	0.48223
16	1.54976	37	0.26434
17	0.66486	38	0.20048
18	1.16454	39	0.25251
19	1.21037	40	1.27723
20	1.27177	41	0.48944
21	1.80392	42	0.29061

TABLE XXXI (Continued)

Index No.	S Value
43	0.77939
44	1.14946
45	0.25615
46	0.64639
47	0.91243
48	2.24222
49	0.86841
50	0.28427
51	0.76853
52	0.55779
53	0.40513
54	1.31775
55	0.17700
56	0.21735
57	0.22881
58	0.37176
59	0.47496
60	0.68122
61	1.86849
62	0.38495

homogeneous than of the heterogeneous groups. When duplication did occur, the starting point of the group that was duplicated, as well as the numbers of indices in the groups when duplication occurred is noted in Appendix B. Thus the homogeneous group which had Index 6 as the starting point was duplicated by the group starting with Index 4 when there were four indices in each group; the group comprised of Indices 4, 5, 7, and 6 is identical to the group comprised of Indices 6, 7, 5, and 4. The indices added to each of these groups in subsequent iterations are, of course, identical.

An interesting phenomenon may be observed in Appendix A; in the great majority of cases, S values (of the groups compared to the GNP Deflator) decreased as additional indices were added to the groups. Of 1,116 S values computed when indices were added to groups, only 54, or 4.8 percent, increased with the addition of another index. Generally, within the range of group sizes tested, the degree of surrogation increased (differences between the averaged price behavior of the index group and the GNP Deflator, as represented by the S value, decreased) with the addition of each asset to the groups. Table XXXII presents the averaged S values of homogeneous and heterogeneous groups of 1 to 10 indices. The tendency for S values to decrease within the range of group sizes presented is apparent (see Figure 1).

TABLE XXXII

AVERAGED S VALUES FOR HOMOGENEOUS AND HETEROGENEOUS GROUPS OF 1 TO 10 INDICES

Group Size	Average S Values for Homogeneous Groups	Average S Values for Heterogeneous Groups
1	.64646	.64646
2	.45097	.36095
3	.35926	.25875
4	.31059	.21065
5	.27983	.18052
6	.25795	.15930
7	.23991	.14457
8	.22618	.13498
9	.21517	.12723
10	.20493	.12164

This is not surprising for the heterogeneous groups, because by definition the next heterogeneous index to be added to each group in an iteration is the one which brings the averaged price behavior of the group nearest to the price behavior of the GNP Deflator.

It is, however, a somewhat surprising result for the homogeneous groups. The next homogeneous index to be added to each group in an iteration is the one which most closely

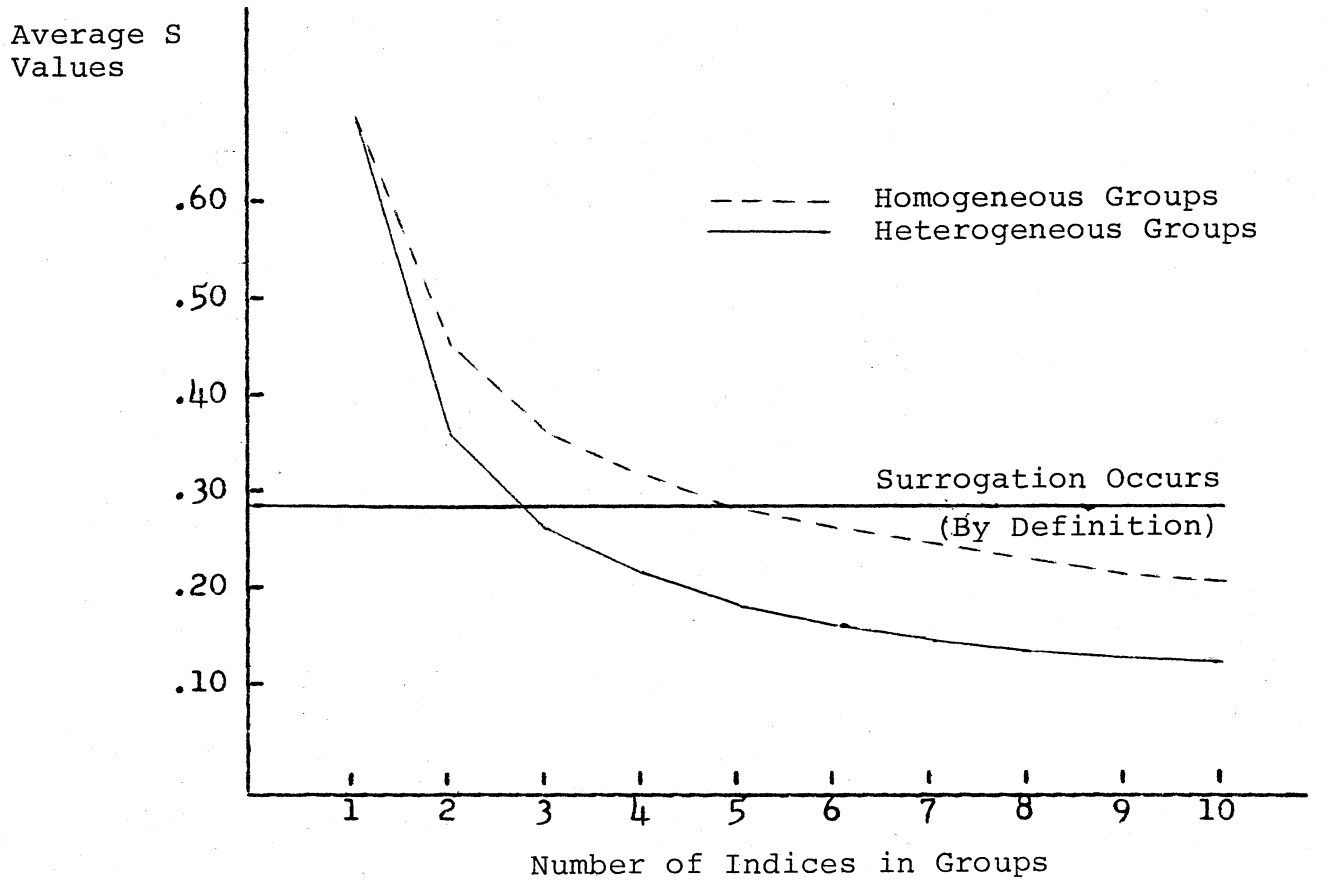

Figure 1. Average S Values for Homogeneous and Heterogeneous Groups

approximates the averaged price behavior of the group--no reference is made to the GNP Deflator. What would seem to be implied by the consistent decrease in S values as homogeneous indices are added to the groups (S values decreased 513 out of 558 times for homogeneous groups, or 92 percent of the time) is that indices with price behavior greatly different from the GNP Deflator tend to be unique. A homogeneous index whose price behavior is more extremely divergent from the GNP Deflator than the original index is less likely to exist than a homogeneous index whose price behavior is less divergent from the GNP Deflator. Because in the overwhelming majority of cases S values decreased with the addition of a homogeneous index, it seems reasonable to assume that indices whose price behavior is not extremely divergent from the GNP Deflator are also for the most part more closely approximated by indices with price movements similar to the GNP Deflator than by indices with price movements dissimilar to the GNP Deflator (which, as already stated, appear to be somewhat unique).

It should be noted that despite the overwhelming tendency for S values to decrease as groups became larger within the range of group sizes 1 to 10, the S value for all groups containing 62 indices was .28759; this implies that S values at some point must begin to increase consistently, as the more divergent indices must eventually be added to the groups. S values therefore do not approach zero asymptotically as group sizes increase.

A second striking phenomenon may be observed in Appendix B. It is apparent from this appendix that certain indices reappear quite frequently as members of different groups. If indices were added to the groups on a random basis, it would be expected that each index would appear approximately nine times in the homogeneous groups and nine times in the heterogeneous groups (558 homogeneous and heterogeneous groups were formed, and there are 62 indices). Instead, the highest frequency of appearance of an index in the homogeneous groups was 61 times, and the highest frequency in heterogeneous groups was 59 times. Indices appearing in 10 or more groups, and the S values of the indices when compared individually to the GNP Deflator (taken from Table XXXI) are shown in Tables XXXIII and XXXIV.

The nonrandom appearance of indices in the groups may be explained by reference to the concept of purposeful diversification which was used in the formation of the groups. Indices were not added randomly to the groups; they were added because either their price behavior most closely approximated that of the existing groups (homogeneous additions) or their price behavior, when averaged with the existing groups, most closely approximated the GNP Deflator (heterogeneous additions).

It has already been noted that the addition of both homogeneous and heterogeneous indices to the groups increased the degree of surrogation (decreased S values) in

TABLE XXXIII

FREQUENCY OF APPEARANCE AND S VALUES OF INDIVIDUAL INDICES APPEARING 10 OR MORE TIMES IN THE HOMOGENEOUS GROUPS

Frequency	Index No.	S Value
61	55	.17700
61	27	.17981
58	38	.20048
50	30	.21621
49	26	.22980
41	45	.25615
36	7	.24406
36	3	.24979
31	57	.22881
28	37	.26434
12	5	.27075
12	6	.28936
11	4	.25871
10	1	.26095
10	2	.26636

TABLE XXXIV

FREQUENCY OF APPEARANCE AND S VALUES OF INDIVIDUAL INDICES APPEARING 10 OR MORE TIMES IN THE HETEROGENEOUS GROUPS

Frequency	Index No.	S Value
59	29	.20812
56	28	.33402
52	56	.21735
52	57	.22881
50	38	.20048
50	9	.23056
45	34	.22749
37	39	.25251
28	45	.25615
27	37	.26434
25	55	.17700
13	1	.26095
11	3	.24979

approximately 95 percent of the cases. It follows that as surrogation is approached or occurs for homogeneous groups, the most like index to be added in the next iteration is one which, since the averaged price behavior of the group has become similar to that of the GNP Deflator, is itself

similar to the GNP Deflator. It would thus be expected that indices which were individually surrogated by the GNP Deflator would appear frequently as the indices most homogeneous to the surrogated groups. This positive relationship between the frequency of appearance of an index in homogeneous groups and the degree of surrogation of the index by the GNP Deflator is illustrated in Table XXXIII.

A similar phenomenon occurs with heterogeneous groups. In heterogeneous iterations, the next heterogeneous index is the one which brings the averaged groups' behavior into the closest approximation of the GNP Deflator. One possible explanation is that divergent indices do not tend to have heterogeneous counterparts which diverge in equal, yet opposite directions from the GNP Deflator. Rather, counterbalancing indices may also tend to be less divergent.

Another possible explanation recognizes the fact that the majority of indices are not extremely divergent from the GNP Deflator; indeed, 34 percent of the indices were originally surrogated. Indices counterbalancing this majority with price movements in an opposite direction, yet of approximately the same magnitude from the GNP Deflator will still be similar to the GNP Deflator. Because of their balancing role, the frequency of appearance of indices as part of heterogeneous groups would not be expected to be directly related to their degree of surrogateship (as are homogeneous indices), but indices which balance a common trend of similar magnitude would be expected to recur

frequently. And it is the case that the frequently-appearing indices in heterogeneous groups are, with one exception, surrogated individually by the GNP Deflator.

With surrogation assumed to take place if the S value of the averaged observations in the groups compared to the GNP Deflator is .28759 or below, surrogation occurred for groups as follows:

TABLE XXXV

SURROGATION OF GROUPS OF HOMOGENEOUS INDICES

Number of Indices in Groups	Number of Surrogated Groups	Number of Unsurrogated Groups	Percent Surrogated
2	28	34	45%
3	31	31	50%
4	40	22	65%
5	41	21	66%
6	46	16	74%
7	50	12	81%
8	52	10	84%
9	55	7	89%
10	57	5	92%

TABLE XXXVI

SURROGATION OF GROUPS OF HETEROGENEOUS INDICES

Number of Indices in Groups	Number of Surrogated Groups	Number of Unsurrogated Groups	Percent Surrogated
2	31	31	50%
3	41	21	66%
4	51	11	82%
5	57	5	92%
6	58	4	94%
7	60	2	97%
8	61	1	98%
9	61	1	98%
10	62	0	100%

Evaluation of the Arguments

Argument Regarding Surrogation of Individual Indices

One argument to be evaluated is whether the GNP Deflator surrogates specific price indices. Thirty-four percent of the individual indices in the study were surrogated by the GNP Deflator; obviously, then, 66 percent were not. This evidence, in the opinion of the researcher, supports the

conclusion that in general individual indices are not surrogated by the GNP Deflator.

In terms of possible policy-making implications, however, the usefulness of the conclusion that the GNP Deflator does not in general surrogate specific indices is limited because of the existence of a sizable proportion (approximately one-third in the sample tested) of exceptions. If used as a guide to action, the conclusion that individual indices are not surrogated would produce an improper response in approximately 1 out of 3 instances (if the sample is representative).

Argument Regarding Differential Surrogation of Homogeneous and Heterogeneous Groups

Tables XXXV and XXXVI, as well as Table XXXII and Figure 1, indicate that heterogeneous groups were surrogated somewhat more rapidly than homogeneous groups. The conclusion as to whether homogeneous and heterogeneous groups are significantly different in the degree to which they are surrogated depends on how one subjectively defines a significant difference in surrogation.

It is the opinion of the researcher that the difference was not significant. Both homogeneous and heterogeneous groups were surrogated very rapidly. The majority of groups (approximately two-thirds) were surrogated by the time heterogeneous groups included three indices, and homogeneous

groups included four (Tables XXXV and XXXVI). Indeed, 50 percent surrogation occurred for heterogeneous groups of two, and homogeneous groups of three indices. This situation would seem to be more accurately reflected by the statement that both types of groups were surrogated rapidly, than by the statement that the difference in surrogation of homogeneous and heterogeneous groups was significant. Data are presented, however, to enable the reader to draw his or her own conclusions.

Implications of the Results

Any generalizations from simulations to real-world situations must be by analogy, and the following should be so interpreted.

In the present simulation, most small groups of equally-weighted homogeneous and heterogeneous indices were surrogated by the GNP Deflator, surrogation occurring rapidly as group size increased. The difference in surrogation of homogeneous and heterogeneous groups was found (subject to personal interpretation) not to be significant.

Arguments for the use of general price-level adjustments, predicated upon the assumption of heterogeneous reinvestment activity, and arguments for the use of specific price-level adjustments, predicated upon the assumption of homogeneous reinvestment activity, were presented in Chapter II. It was noted that the arguments become empty in a practical sense if results of the two approaches are

substantially identical.

By analogy, results of this simulation lend evidence that despite reinvestment assumptions, current replacement costs of asset holdings are surrogated by general price-level adjusted statements for most firms with asset investments in more than one area, and for a substantial minority (approximately one-third in this study) of firms with investment in a single area.[4] This generalization is subject to many limitations, as discussed earlier; the study does, however, provide preliminary evidence that the arguments as to reinvestment activity and relative merits of general and specific price-level adjustments may be meaningless for policy-making purposes, as a GNP Deflator approach would appear to accomplish in most cases (with the inclusion of monetary gains and losses) results advocated by current replacement cost theorists. Further research will be required to determine the extent to which the limitations of the present study affected results obtained.

Summary

Results of the study are presented in this chapter. The evidence supports the conclusion that in general individual

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[4]It should be noted that few items which would normally be classified as plant and equipment were tested, although some of the items could certainly become components of plant and equipment assets. This study, however, less strongly supports the conclusion as to results under the two methods in regard to depreciation expense than it does as regards cost of goods sold.

price indices are not surrogated by the GNP Deflator, but small groups of indices are surrogated. Both homogeneous and heterogeneous groups of indices were surrogated very rapidly, the majority (approximately two-thirds) of groups being surrogated by the time heterogeneous groups included three indices, and homogeneous groups included four. In the opinion of the researcher, the difference in rates of surrogation of homogeneous and heterogeneous groups was not significant, although homogeneous groups were surrogated somewhat more rapidly than heterogeneous groups.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

A considerable amount of discussion of the relative merits of using specific price-level adjustments (current replacement costs) versus general price-level adjustments in times of changing price levels may be found in the literature. Many of these arguments were presented in Chapter II; for the most part, the various advocates postulate (sometimes implicitly) who uses the data, and the users' particular decision-model requirements, then supports logically a proposal which provides the postulated requirements.

Arguments were presented in which theorists took the position that underlying a specific price-level approach is the assumption that firms reinvest homogeneously, and underlying a general price-level approach is the assumption that firms diversify heterogeneously (the degree of maintenance or erosion of capital, defined as specific or general purchasing power, being the postulated decision-model requirement in these schemes). The type of reinvestment activity was seen as the determining factor in choosing specific or general adjustments.

An assumption required to make the specific versus general index controversy meaningful in a policy-making

sense is that applications of the two methods provide significantly different results. Some have argued that they do not; that the general index surrogates most individual indices, and therefore results of the two approaches are, from a practical if not a conceptual viewpoint, interchangeable. Others have argued that the general index does not surrogate specific individual indices, nor does it surrogate homogeneous groups of indices. The purpose of the study was to lend empirical evidence to the arguments that (1) the general index surrogates specific individual indices, and (2) homogeneous and heterogeneous groups of indices are significantly different in the degree to which they are surrogated by the general index.

Perfect surrogation was defined in an accounting context as occurring when percentage price changes of two indices are equal. In the study, a monotonic measure of relative surrogateship called an S value was developed; the property captured in the measure was the relative convergence of percentage price changes in the underlying indices, with perfect convergence (complete equality of percentage price changes) being indicated by an S value of zero. Increasing S values indicated increasing divergence of underlying percentage changes.

Surrogation was operationally defined with reference to the S value obtained when all indices in the sample were averaged and compared to the GNP Deflator. This cut-off point was later used in classifying individual indices or

averaged groups of indices as being surrogated or not being surrogated by the GNP Deflator.

Individual indices were compared to the GNP Deflator, using the S value methodology, to determine the proportion of the individual indices surrogated. Homogeneous and heterogeneous groups of indices were developed, homogeneous and heterogeneous indices being operationally defined in terms of the price behavior of the indices relative to the price behavior of the indices used as starting points for the groups. Each original index was used as a starting point for the development of the homogeneous and heterogeneous groups. Homogeneous and heterogeneous groups of two to ten indices were compared to the GNP Deflator, to determine the proportions of the groups of various sizes that were surrogated, as well as to evaluate the argument that homogeneous and heterogeneous groups were significantly different in the degree to which they were surrogated by the GNP Deflator.

Conclusions

It was found that while a significant proportion (approximately one-third) of the individual indices were surrogated by the GNP Deflator, the majority of individual indices were not. It was also found that surrogation of groups of both homogeneous and heterogeneous indices took place very rapidly, with a 50 percent level of surrogation

occurring for heterogeneous groups of two indices, and homogeneous groups of three indices. The difference in surrogation of homogeneous and heterogeneous groups was not, in the opinion of the researcher, significant.

By analogy, the results implied that reinvestment assumptions may not be critical in the choice between specific and general price-level adjustments. Homogeneous and heterogeneous groups of equally-weighted indices were not significantly differentially surrogated; both were surrogated rapidly by the GNP Deflator. The implication from this preliminary study is that a GNP Deflator approach would seem to approximate results obtained by a current replacement cost approach in most cases. This is, however, a generalization by analogy from a simulation; the effect of limiting factors in the study (equal weightings of indices, nonbehavioral definition of surrogateship, nonrandom sample, etc.) upon results obtained, and therefore upon conclusions drawn, is not known.

Suggestions for Further Research

The present study provided preliminary evidence directed toward answering the question of whether current replacement costs are surrogated by general price-level adjustments in most cases. The issue is far from conclusively resolved at this point.

One of the main areas to be explored in further research is the extent to which the use of equal weights for

the indices affected results. A sensitivity analysis of weightings, hopefully based on real-world data as to proportionate asset holdings of firms, would be a desirable refinement in future simulations. It is possible that relative weightings vary systematically for firms with homogeneous as opposed to heterogeneous asset holdings; whether or not this occurs, it would be desirable to incorporate representative variable weightings in future simulations.

The extent of surrogation of actual asset holdings of firms might also be evaluated in a case study approach. A trade-off exists between the generality of results obtained by examining real-world data, and the greater volume of data that can be manipulated in a simulation; additionally, the refinement of comparing results under different merger strategies (homogeneous and heterogeneous) would probably have to be sacrificed (because of formidable problems of data collection) in case studies. It is believed, however, that a case study approach could generate valuable, though probably not conclusive, evidence.

Another refinement for studies in this area would be to investigate surrogateship (or to attempt to define surrogateship) from a behavioral approach. Exploring this problem would involve the researcher in an attempt to define materiality, as mentioned previously, as the question of what magnitude of difference in financial statements is required to cause different decisions would have to be

answered.

Studies involving different time periods and different samples would be desirable. It is believed that replications and refinements should take place until the question of whether current replacement costs are surrogated by GNP Deflator adjustments has been conclusively answered for policy-making purposes.

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APPENDIX A

S VALUES OBTAINED WHEN HOMOGENEOUS AND HETEROGENEOUS GROUPS OF INDICES WERE COMPARED TO THE GNP DEFLATOR

TABLE XXXVII

S VALUES OBTAINED WHEN HOMOGENEOUS GROUPS OF INDICES WERE COMPARED TO THE GNP DEFLATOR

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
1	.26366	.24584	.25052	.23232	.23441	.21986	.20725	.20378	.19326
2	.26333	.24584	.25052	.23232	.23441	.21986	.20725	.20378	.19326
3	.19654	.17425	.16468	.16213	.16506	.17311	.16835	.16592	.15558
4	.24954	.23663	.24608	.23633	.23441	.21986	.20725	.20378	.19326
5	.24954	.23663	.24608	.23633	.23441	.21986	.20725	.20378	.19326
6	.26437	.25295	.24608	.23633	.23441	.21986	.20725	.20378	.19326
7	.26437	.25295	.24608	.23633	.23441	.21986	.20725	.20378	.19326
8	.32596	.31456	.27055	.24110	.21929	.21446	.20505	.19313	.22274
9	.22586	.22573	.22707	.23645	.22899	.22760	.21505	.20378	.19326
10	.52813	.41371	.36450	.33114	.30906	.29478	.28945	.26994	.25293
11	.38545	.29665	.25093	.22274	.21393	.19893	.18410	.17400	.17650
12	.67080	.47756	.38008	.31872	.28723	.26911	.24601	.22723	.22366
13	.93564	.67012	.52088	.43157	.37143	.32476	.29623	.27759	.25526

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
14	1.11216	1.04011	1.02886	.84319	.70460	.60570	.53017	.47435	.42547
15	.93564	.67012	.52088	.43157	.37143	.32476	.29623	.27759	.25526
16	.89049	.61657	.48093	.39728	.34863	.31342	.28046	.26799	.25159
17	.42852	.31993	.26296	.23706	.21233	.20324	.19103	.18130	.18099
18	.65714	.46535	.37021	.31198	.27367	.25850	.23516	.22032	.21093
19	.98190	.94285	.73258	.59010	.49757	.43216	.38367	.34563	.31524
20	.74790	.53147	.41738	.35070	.31349	.27742	.25390	.23391	.21839
21	1.14267	.79734	.62069	.51035	.42732	.37988	.34529	.30923	.29251
22	.55094	.40355	.33239	.30312	.27163	.24637	.22945	.21403	.19923
23	.47153	.35799	.31755	.29485	.26893	.26140	.24136	.23488	.22211
24	.44655	.33435	.27946	.25794	.23268	.22479	.21433	.20134	.20274
25	.49488	.36994	.30424	.26420	.24844	.22978	.21461	.20050	.19093
26	.20512	.19184	.18647	.18296	.17847	.17282	.17125	.16592	.15588
27	.17244	.17512	.18647	.18296	.17847	.17282	.17125	.16592	.15588
28	.21431	.17640	.16050	.16389	.15255	.15397	.15037	.14651	.14567
29	.19216	.16407	.15247	.16102	.15479	.15690	.15583	.15986	.15004

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
30	.19559	.18507	.17748	.18296	.17847	.17282	.17125	.16592	.15588
31	.40189	.29138	.23856	.20901	.19022	.17524	.17639	.18025	.18948
32	.24342	.21018	.19496	.19216	.18589	.17972	.17613	.17250	.16740
33	.30214	.24635	.22247	.21851	.20486	.19513	.19330	.17922	.17480
34	.20233	.17918	.16934	.16021	.16620	.15915	.16594	.15784	.15491
35	.24270	.21536	.19835	.18421	.18475	.17192	.17761	.16793	.16318
36	.31941	.26160	.23448	.22786	.21239	.20076	.19306	.18702	.17889
37	.21360	.19195	.18269	.18681	.17847	.17282	.17125	.16592	.15588
38	.18511	.17512	.18647	.18296	.17847	.17282	.17125	.16592	.15588
39	.27134	.22577	.19969	.18364	.18281	.17105	.16790	.16468	.15949
40	.77473	.52866	.40342	.32963	.29185	.26502	.23451	.21444	.21069
41	.38296	.31419	.27436	.24858	.24114	.22547	.22533	.22453	.21527
42	.27134	.22577	.19969	.18364	.18281	.17105	.16790	.16468	.15949
43	.61187	.47089	.39091	.35198	.31388	.29363	.27096	.26860	.26322
44	.72993	.55741	.46276	.40093	.36783	.34077	.31487	.30007	.28062
45	.21124	.19236	.18456	.18957	.18180	.17311	.16835	.16592	.15588

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
46	.40333	.31996	.28098	.26631	.24633	.22961	.22084	.21130	.20205
47	.52270	.38746	.31723	.28792	.26798	.24285	.21912	.20806	.20344
48	1.40609	1.02249	.82264	.69560	.60629	.53754	.48672	.44872	.41180
49	.58126	.45718	.38663	.34111	.30969	.28453	.26714	.24688	.23014
50	.23341	.21095	.20078	.20464	.19613	.18915	.18453	.18120	.17544
51	.51034	.40532	.35733	.31707	.29866	.27230	.26018	.24729	.23501
52	.38656	.31739	.28239	.27014	.25142	.23638	.21809	.21153	.19845
53	.27683	.22902	.20697	.20291	.18931	.18061	.17526	.17149	.16514
54	.84159	.64135	.52910	.46937	.41582	.38015	.35317	.33468	.30874
55	.17244	.17512	.18647	.18296	.17847	.17282	.17125	.16592	.15588
56	.15108	.14574	.14964	.16221	.16306	.15170	.15249	.14990	.14574
57	.18182	.16686	.16342	.17332	.16982	.17282	.17125	.16592	.15588
58	.25836	.22184	.19966	.20266	.19117	.18494	.18254	17600	.17306
59	.29198	.23132	.19811	.19736	.19717	.18851	.17965	.17522	.16779
60	.41266	.31873	.26595	.24796	.23883	.22548	.21860	.20310	.18846
61	1.03741	.73025	.56923	.47089	.40386	.36049	.32394	.29470	.27422

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
62	.26489	.22119	.20191	.18743	.19083	.18807	.18056	.16947	.16118

TABLE XXXVIII

S VALUES OBTAINED WHEN HETEROGENEOUS GROUPS OF INDICES WERE COMPARED TO THE GNP DEFLATOR

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
1	.17983	.13631	.12215	.11583	.11060	.10465	.10239	.09643	.09448
2	.18270	.13779	.12228	.11552	.11034	.10469	.10238	.09647	.09389
3	.18217	.14611	.13410	.12124	.10683	.09853	.09693	.09523	.09433
4	.17316	.13532	.12325	.11927	.11450	.10738	.10256	.09802	.09831
5	.18336	.14558	.13426	.12306	.11328	.10777	.10491	.10141	.10225
6	.19512	.15760	.13833	.12644	.11378	.10708	.10101	.09866	.09845
7	.16788	.13741	.12603	.11972	.11111	.10729	.10129	.09908	.09944
8	.23585	.19150	.16661	.15462	.14426	.13256	.12082	.11625	.11354
9	.15633	.12527	.11687	.10963	.10030	.09593	.09324	.09303	.09283
10	.33957	.23425	.18594	.15900	.14576	.13023	.11799	.11158	.10897
11	.32990	.24601	.20336	.17835	.16322	.15397	.14557	.13382	.12437
12	.50517	.34448	.26078	.22221	.19436	.17083	.15529	.14459	.13673
13	.52370	.34682	.26320	.21409	.18439	.16251	.14232	.12985	.11992

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
14	.69841	.46987	.35192	.27992	.23053	.19567	.17390	.15819	.14619
15	.42924	.29342	.23064	.18572	.15641	.13753	.12474	.11611	.10939
16	.74923	.48254	.35270	.28389	.23390	.20331	.18145	.16343	.14944
17	.35608	.24367	.19153	.16023	.14013	.12473	.11876	.10959	.10480
18	.56746	.37473	.28571	.23845	.20480	.18039	.16337	.15101	.14133
19	.55619	.36578	.27833	.22134	.18267	.15724	.13958	.13156	.12195
20	.65103	.43545	.32784	.26405	.22386	.19316	.17175	.15320	.14001
21	.89858	.58267	.43086	.34406	.28733	.24911	.21933	.19708	.17806
22	.49096	.33913	.26003	.21883	.18946	.16928	.15462	.14591	.13558
23	.38136	.26136	.19976	.16945	.15301	.14223	.13779	.12973	.12181
24	.42543	.30503	.24654	.21227	.19223	.17641	.15910	.14680	.13869
25	.44266	.30428	.24245	.20200	.17570	.15855	.14685	.13935	.13394
26	.17164	.13717	.12933	.11678	.10754	.10325	.09972	.09876	.09802
27	.14680	.12020	.11687	.10963	.10030	.09593	.09324	.09303	.09283
28	.20152	.15121	.12773	.11044	.09820	.09409	.09446	.09240	.09140
29	.14046	.12020	.11687	.10963	.10030	.09593	.09324	.09303	.09283

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
30	.17436	.14095	.13172	.11805	.10405	.09770	.09739	.09539	.09617
31	.36819	.25466	.19581	.16506	.14477	.12896	.11822	.11021	.10761
32	.21530	.16773	.15504	.14110	.12859	.11934	.11669	.11296	.10686
33	.29037	.21343	.18126	.15707	.14453	.13458	.12543	.11451	.11092
34	.16915	.14907	.13258	.11323	.10090	.09573	.09324	.09303	.09283
35	.19625	.15749	.14438	.12824	.11010	.09971	.09844	.09579	.09473
36	.28645	.21218	.17961	.15972	.14716	.13243	.12490	.11707	.11125
37	.18395	.13943	.12765	.11558	.10510	.10177	.10030	.09648	.09254
38	.15740	.12852	.12081	.11091	.09984	.09409	.09446	.09240	.09140
39	.16418	.13434	.12293	.11522	.10779	.09775	.09705	.09240	.09140
40	.62199	.41225	.30854	.25328	.21746	.19710	.17867	.16345	.15086
41	.30333	.23611	.20148	.17293	.15383	.14166	.13149	.12837	.12604
42	.18314	.14642	.13203	.12417	.11474	.10415	.10266	.09735	.09583
43	.46798	.33678	.27146	.23167	.20313	.18673	.17327	.16021	.15161
44	.68095	.49117	.38977	.32778	.28952	.26043	.23811	.21978	.20309
45	.18028	.13888	.12736	.11569	.10435	.09772	.09378	.09193	.09140

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
46	.37603	.27707	.23387	.20209	.17706	.15981	.15445	14790	.13997
47	.48712	.34662	.27332	.22854	.19756	.17798	.16453	.15305	.14395
48	1.17303	.81219	.62745	.51660	.44241	.38771	.34544	.31265	.28417
49	.51935	.37002	.29720	.25295	.21385	.18679	.17346	.16156	.15705
50	.19940	.15671	.14367	.12711	.11431	.10904	.10561	.10477	.10395
51	.47160	.34746	.28922	.24847	.22265	.19852	.18043	.17040	.16313
52	.35183	.26048	.21447	.18436	.16780	.15385	.14460	.13725	.13228
53	.24688	.18210	.14973	.13639	.12648	.11830	.11394	.10775	.10516
54	.79023	.58018	.46227	.38623	.33454	.29622	.26953	.24712	.22982
55	.15022	.12303	.11830	.10785	.09819	.09409	.09446	.09240	.09140
56	.14046	.12020	.11687	.10963	.10030	.09593	.09324	.09303	.09283
57	.15437	.12697	.11821	.10785	.09819	.09409	.09446	.09240	.09140
58	.23296	.17618	.14624	.12585	.11828	.11121	.10735	.10658	.10465
59	.26434	.18360	.14356	.12678	.11512	.11119	.11344	.10696	.10281
60	.37687	.26543	.21768	.18390	.16042	.14526	.13161	.12867	.12296
61	.92252	.61762	.45672	.36614	.30520	.25739	.22971	.20762	.18917

Starting Pt.-- Index No.	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8	Groups of 9	Groups of 10
62	.21641	.16586	.14295	.12635	.11954	.11559	.10958	.10306	.09844

APPENDIX B

IDENTIFICATION NUMBERS OF INDICES COMBINED TO FORM HOMOGENEOUS AND HETEROGENEOUS GROUPS

TABLE XXXIX

IDENTIFICATION NUMBERS OF INDICES COMBINED TO FORM HOMOGENEOUS GROUPS

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
1	2	7	6	4	5	27	55	9	38		
2	1	7	6	4	5	27	55	9	38	1	2
3	27	55	38	30	26	45	37	57	7		
4	5	7	6	1	2	27	55	9	38	1	6
5	4	7	6	1	2	27	55	9	38	4	2
6	7	5	4	1	2	27	55	9	38	4	4
7	6	5	4	1	2	27	55	9	38	6	2
8	39	42	27	55	38	26	7	30	46		
9	7	4	5	6	1	2	27	55	38	1	9
10	11	7	5	4	2	1	6	27	55		
11	7	27	55	38	26	30	56	39	5		
12	36	55	27	38	30	26	7	56	5		

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
13	15	45	55	27	3	38	30	26	57		
14	15	13	19	45	30	55	27	3	38		
15	13	45	55	27	3	38	30	26	57	13	2
16	62	30	55	27	26	34	38	45	3		
17	50	55	27	30	38	26	34	3	45		
18	45	27	55	3	38	26	30	37	57		
19	15	13	45	30	55	27	3	34	38		
20	62	30	27	55	26	38	34	29	57		
21	23	9	7	56	27	2	1	55	4		
22	38	27	55	26	30	45	7	37	3		
23	7	1	2	6	4	5	27	9	55		
24	27	55	38	30	7	26	9	56	5		
25	26	55	27	38	30	57	37	7	45		
26	27	55	38	30	37	57	45	3	7	3	9
27	55	38	26	30	37	57	45	3	7	26	4

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
28	27	55	38	26	30	45	3	37	57		
29	34	55	27	30	38	26	3	45	37		
30	55	27	38	26	37	57	45	3	7	26	5
31	38	27	55	26	30	7	1	2	6		
32	27	55	38	26	30	37	57	45	3		
33	27	55	38	26	30	57	37	7	45		
34	30	55	27	38	26	3	45	37	57		
35	30	55	27	38	26	3	45	37	57		
36	27	55	38	26	30	37	57	45	3		
37	27	55	38	26	30	57	45	3	7	26	6
38	27	55	26	30	37	57	45	3	7	27	3
39	42	27	55	38	26	30	7	45	3		
40	53	27	55	38	26	3	30	57	45		
41	50	27	55	38	26	30	6	7	39		
42	39	27	55	38	26	30	7	45	3	39	2

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
43	41	27	55	26	38	7	30	50	6		
44	30	55	27	38	26	45	3	35	34		
45	27	55	38	26	30	3	37	57	7	3	7
46	27	55	38	26	30	34	45	3	29		
47	55	27	38	30	26	34	29	3	45		
48	51	30	26	55	27	38	5	4	57		
49	26	27	55	38	30	37	57	45	3		
50	27	55	38	26	30	37	57	45	3		
51	27	55	30	38	26	37	45	3	57		
52	27	55	38	26	30	37	45	57	7		
53	27	55	38	26	30	37	57	45	3		
54	38	27	55	26	30	6	7	39	45		
55	27	38	26	30	37	57	45	3	7	27	2
56	55	27	38	26	30	7	45	3	37		
57	27	55	38	26	30	37	45	3	7	26	7

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Groups	No. of Indices in Group When Duplication Occurred
58	27	55	38	26	30	37	45	3	57		
59	55	27	38	30	26	37	57	45	3		
60	55	27	38	30	26	57	37	45	7		
61	32	57	7	27	55	26	38	30	4		
62	30	55	27	38	26	45	3	7	37		

TABLE XL

IDENTIFICATION NUMBERS OF INDICES COMBINED TO FORM HETEROGENEOUS GROUPS

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
1	56	29	55	57	28	9	34	38	45		
2	56	29	55	57	28	9	34	38	37		
3	56	29	9	57	28	38	34	39	55		
4	29	55	27	57	56	28	38	34	39		
5	29	27	57	28	55	56	38	3	39		
6	29	56	45	28	57	34	38	9	55		
7	29	56	55	57	28	38	34	45	39		
8	29	55	4	56	57	28	34	38	9		
9	29	27	56	57	28	38	34	39	45		
10	38	3	30	37	29	28	9	56	57		
11	29	55	39	9	56	38	3	28	37		
12	45	29	42	2	56	28	37	34	38		

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
13	37	29	56	9	39	1	34	28	57		
14	8	5	29	37	2	38	34	28	56		
15	56	37	29	9	39	1	57	28	38		
16	57	53	32	36	1	28	2	37	4		
17	57	9	28	38	58	29	4	3	37		
18	56	29	6	39	34	9	57	28	38		
19	8	1	29	37	4	2	57	34	39		
20	37	56	39	45	9	29	53	4	31		
21	37	29	34	30	57	59	1	17	9		
22	29	37	34	45	39	1	56	9	28		
23	29	38	34	57	56	27	28	17	37		
24	29	27	4	57	3	35	28	38	37		
25	50	29	28	37	34	9	38	56	45		
26	29	56	9	57	28	38	34	39	45		
27	29	56	9	57	28	38	34	39	45	9	4

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
28	56	29	55	9	57	38	34	39	45		
29	56	27	9	57	28	38	34	39	45	27	3
30	56	29	9	28	57	38	39	3	37		
31	26	57	34	9	56	28	29	39	45		
32	56	29	55	9	28	57	38	34	39		
33	56	29	9	55	28	38	34	37	39		
34	27	56	57	28	9	38	29	39	45	9	8
35	56	29	9	57	28	38	39	45	37		
36	56	29	2	55	28	57	34	38	9		
37	29	56	9	55	28	57	34	38	39		
38	56	29	9	57	28	55	34	39	45	28	7
39	29	55	9	57	28	56	34	38	45	28	9
40	6	29	9	55	56	1	59	57	38		
41	29	56	28	9	57	34	38	45	55		
42	29	55	9	57	56	28	34	38	45		

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
43	29	9	28	55	56	57	34	1	38		
44	56	29	37	9	39	1	57	28	3		
45	29	56	9	57	28	38	34	39	55	28	10
46	56	29	9	57	28	55	38	34	39		
47	56	57	28	3	9	38	29	39	37		
48	50	29	1	57	39	3	38	9	37		
49	29	42	45	34	28	9	57	39	38		
50	29	56	9	28	57	38	34	39	45		
51	29	56	1	37	28	34	31	57	9		
52	56	29	45	9	28	57	34	1	38		
53	29	4	55	57	28	30	7	3	38		
54	56	29	45	9	28	35	34	37	2		
55	29	56	9	57	28	38	34	39	45	28	6
56	29	27	9	57	28	38	34	39	45	29	2
57	56	29	9	55	28	38	34	39	45	55	5

Starting Point-- Index No.	Index No. Added To Form Groups Of: 2	3	4	5	6	7	8	9	10	---If Duplication Occurred--- Starting Pt. of Duplicate Group	No. of Indices in Group When Duplication Occurred
58	29	9	28	38	57	56	34	55	1		
59	9	29	38	56	57	28	34	31	39		
60	29	7	28	38	34	39	45	37	9		
61	23	53	34	45	17	33	37	56	28		
62	56	57	9	29	39	38	28	3	37		

VITA

Katherine Jane Hohl

Candidate for the Degree of

Doctor of Philosophy

Thesis: AN INVESTIGATION OF THE SURROGATESHIP OF THE GNP DEFLATOR FOR WHOLESALE PRICE INDICES

Major Field: Business Administration

Biographical:

Personal Data: Born in Tulsa, Oklahoma, April 7, 1947, the daughter of Dr. James F. and Ms. Betty Chowning Hohl.

Education: Graduated from Ada High School, Ada, Oklahoma, in 1965; received the Bachelor of Arts degree in Sociology from the University of Oklahoma in 1969; received the Master of Science degree in Accounting from Oklahoma State University in 1972; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1977.

Professional Experience: Staff Accountant, Arthur Andersen and Co., 1970-71; Part-time Instructor, Oklahoma State University, 1972-75; Assistant Professor, Department of Quantitative Analysis and Control, Bowling Green State University, 1975-present.

Professional Organizations: American Accounting Association, American Institute of Certified Public Accountants.